BIOMECHANICAL PELVIC BLOCKING ON SACROILIAC DYSFUNCTION AND ITS IMMEDIATE EFFECTS ON GAIT

A dissertation submitted to the Faculty of Health Sciences, University of Johannesburg, in partial fulfilment of the requirements for the degree of Master of Technology: Chiropractic

by

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DECLARATION

I, Sharné Pillay, declare that this dissertation is my own, unaided work. It is being submitted as partial fulfilment for the Master's Degree in Technology, in the program of Chiropractic, at the University of Johannesburg. It has not been submitted before for any degree or examination in any other Technikon or University.

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Sharné Pillay

On this day the **7th** of the month of **May** 2019.

DEDICATION

Firstly, to my extraordinary parents, Elvis and Mumsie Pillay. Words cannot describe how appreciative I am to be blessed with parents like you. It’s impossible to thank you for everything you have done and sacrificed throughout the years. The morals and values that you have instilled in me has taught me to embrace life with open arms. I know that I can face any challenge with the both of you by my side. Your constant love, motivation and guidance has made me into the person I am today. You are my role models, my life, my everything. I love you unconditionally.

To my brothers, Preston and Presley Pillay, you two have been the greatest gift, I don't know what I would do without you. I consider myself lucky to have siblings who never fail to make me laugh and are always there to protect me. I cherish the crazy moments we have together and thank you for always being there for me.

My Guardian Angel, Charlene Reddy, your inspirational words have carried me through the past few years and will continue to motivate me. You taught me how to dream beyond limits and that I could do anything if I set my mind to it. There is not a day that goes by that I don’t miss you, I know you’re up there smiling down at me.

To my family and friends, your love and support through this journey has kept me going, I hope I have made you proud.

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Lastly, to all the participants; without you, this research wouldn't be possible.

ABSTRACT

Purpose: The lumbosacral motion and sacroiliac joints play an important role in transmitting the forces from the upper body to the lower limb during the gait cycle. Dysfunction within the lower limb will increase the strain on the joints to accommodate the decreased motion resulting in an abnormal gait pattern. Biomechanical pelvic blocking is a treatment protocol that can be used to treat sacroiliac dysfunction. There is no research conducted on whether biomechanical pelvic blocking influences the spatiotemporal parameters of gait. The aim of this study was to determine whether biomechanical pelvic blocking had an immediate effect on the gait parameters using the Zebris FDM gait analysis system.

Method: One hundred participants were used in this study and were divided into two equal groups of fifty participants each. Males and females were included and had to be between the age of 18-30 years old. The participants were required to sign an informed consent form and a case history was taken to determine whether they could be included in the study. The initial gait measures were then taken on the Zebris FDM gait analysis system. A physical examination was then performed along with the treatment according to the participants sacroiliac joint restriction.

Procedure: Participants in Group A received treatment with the biomechanical pelvic blocks for eight minutes whilst participants in Group B were not treated but were required to be in the prone position for eight minutes as the control group. Participants were then analysed again on the Zebris FDM gait analysis system after treatment to collect the objective data. The Zebris FDM gait analysis system uses force sensors on its calibration plate to analyse static and dynamic parameters of gait. The measurable parameters were calculated on the WinFDM program on a computer which then produces a report of the results.

Results: The parametric tests for data analysis was used to compare the data. The Paired t-test was used to analyse the data between the two treatment times within a group. The Independent t-test was used to compare the data between the two groups. Minor changes within the data was found as there were improvements in step length, stance phase, load response phase, midstance phase, swing phase, total double support phase, stride length, stride time and cadence. However, they were within the normal range values.

Conclusion: There was no statistically significant data in this study to demonstrate that biomechanical pelvic blocking had an immediate effect on the spatiotemporal parameters of gait. However, this treatment method can be used for patients who are contra-indicated to chiropractic manipulation. Since biomechanical pelvic blocking does not reveal significant immediate changes in the sacroiliac joint motion, multiple treatments may be required.

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CHAPTER 1 : INTRODUCTION

1.1 Problem Statement

Walking is a vital component in human existence that allows us to perform our daily activities. Any disturbance in the anatomy of the body, especially in the lower limb, will result in abnormal or altered gait. It is common for our body to present with a functional long and short leg which can be corrected with chiropractic treatment (Gatterman, 2004).

Normal gait patterns are essential biomechanically as it prevents pain and discomfort in the lower back, hips, knees, ankles and feet. The sacroiliac joints are important in the kinematic chain and any disturbance in its normal function will result in compensation of the joints in the lower limb. By solely correcting the motion of the sacroiliac joint with chiropractic manipulation, there was an immediate change in the gait parameters (Schooling, Yelverton & Moodley, 2013).

Biomechanical pelvic blocking was derived from the Sacro-Occipital Technique (SOT). The premise for this technique was the use of wedges that were placed beneath the pelvis according to the functional leg length inequality. The adjustment occurred as the wedges served as a fulcrum as gravity pulled the joint into place. (Bergmann & Peterson, 2010).

1.2 Aim

The aim of this study was to determine whether biomechanical pelvic blocking has an immediate effect on the spatiotemporal parameters of gait as the sacroiliac joint is an essential part of the kinematic chain in the body.

1.3 Benefits of the Study

Biomechanical pelvic blocking is a technique used by chiropractors to correct the sacroiliac joint restrictions related to a functional leg length inequality. Patients who have contra-indications for chiropractic manipulation can use this technique to correct any sacroiliac joint restrictions. There are no limitations to this technique and can be used on any age group or patient size.

Chiropractors, biokineticists and podiatrists can use this information with their patients which can help build a multidisciplinary approach to patient care. This ensures better recovery and functionality for the patient.

CHAPTER 2 : LITERATURE REVIEW

2.1 Introduction

In the following chapter, the essential anatomy of the sacroiliac joint as well as the lower limb will be discussed along with their biomechanics. The gait cycle will be explained in conjunction with the measurable parameters. The biomechanical pelvic blocking technique will be explained along with its advantages.

2.2 Gross Anatomy

2.2.1 Sacroiliac joint anatomy

The sacroiliac joints are the auricular shaped articulations between the sacrum and the ilium. Anteriorly, the joint is classified as a true synovial joint which is auricular in shape and is covered with articular cartilage. Posteriorly, the joint is classified as a syndesmosis joint between the tuberosities of the sacrum and ilium surrounded by ligaments. The sacroiliac joint plays an important role in weight-bearing which then compromises the movement, making it very limited (Moore, Dalley, & Agur, 2014).

According to Moore, Dalley & Agur (2014), the sacroiliac ligaments are responsible for transferring the weight from the axial skeleton to the ilia. During standing, the weight is transferred to the femur, and during sitting it is transferred to the ischial tuberosities. The ligaments provide stability but limit the range of motion.

The anterior sacroiliac ligaments form part of the anterior fibrous capsule of the joint. The position of the anterior sacroiliac ligament prevents separation of the joints surfaces by opposing translation of the sacrum superiorly and inferiorly (Marieb, Wilhelm & Mallatt, 2017).

Posteriorly, there is no joint capsule present on the sacroiliac joint; the interosseous ligaments form the posterior border of the joint space. The iliolumbar, sacrotuberous and sacrospinous ligaments (Figure 2.1) are the accessory ligaments (Marieb, Wilhelm & Mallatt, 2017.

Immobility of the sacrum on the two ilia is due to the complexity of the sacroiliac ligaments and prevents rotation in the x-axis (Calvillo, Skaribas, & Turnipseed, 2000).

The anterior aspect of the sacroiliac joint is innervated from nerve roots, L2 to S2 whereas posteriorly the innervation arises from the lateral branches from the dorsal rami of L4 to S3 (Calvillo, Skaribas, & Turnipseed, 2000).

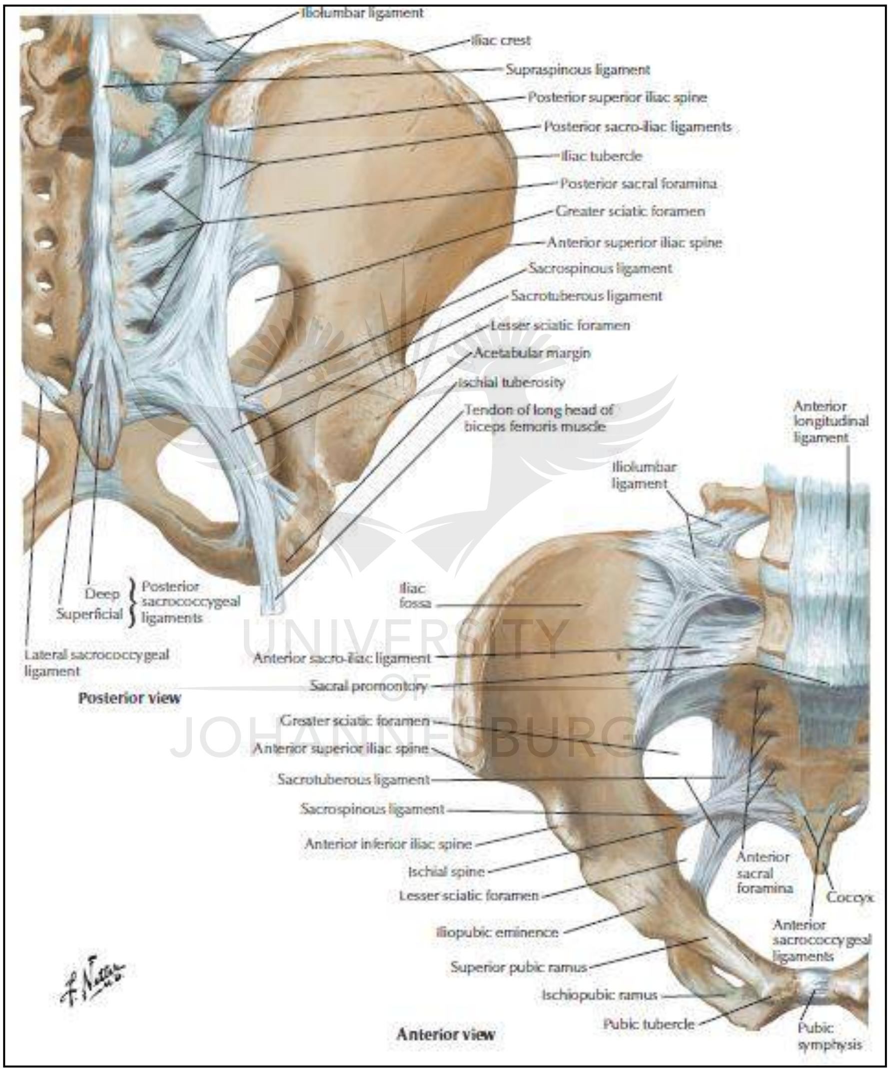

Figure 2.1: Bones and Ligaments of the Pelvis (Netter, 2017)

2.2.2 Hip joint anatomy

The hip joint is a ball-and-socket joint which is very stable. It is the articulation between the femoral head and the acetabulum of the pelvis (Moore, Dalley, & Agur, 2014).

The acetabulum is the fusion of the ilium, ischium and pubis of the pelvis. It forms a Y-shaped triadicate cartilage which is orientated caudally by 45° and 15° anteriorly. The force, during weight bearing and gait, is distributed to the femur through the hip joint (Moore, Dalley, & Agur, 2014). Forces from the ground up are transferred through this joint as well as the forces from the trunk, neck and head (Sato & Sato, 2015).

The hip joint has increased stability through the ligaments that surround it. These ligaments protect the joint from external forces and limit a certain range of motion (Moore, Dalley, & Agur, 2014).

The capsule of the hip joint is known for providing the vascular supply to the femoral head in adults. The ligaments that surround this capsule are the iliofemoral and ischiofemoral ligaments (Figure 2.2). The Y-ligament of Bigelow, also known as the iliofemoral ligament, originates from the ASIS (anterior superior iliac spine) and the acetabulum which spirals medially to insert along the intertrochanteric line anterior to the joint. Its main function is to restrict extension of the hip joint whilst providing static limitations with the full hip extension which allows for an erect posture as this will decrease muscle activity (Hewitt, Guilak, Glisson, & Vail, 2001).

The ischiofemoral ligament originates from the ischial rim of the acetabulum and follows a spiral pattern along with the iliofemoral ligament as it crosses the hip joint and inserts itself around the posterior aspect of the femoral neck. Due to its anatomical orientation, this prevents internal rotation and adduction when the hip is in the flexed position (Hewitt, Guilak, Glisson, & Vail, 2001).

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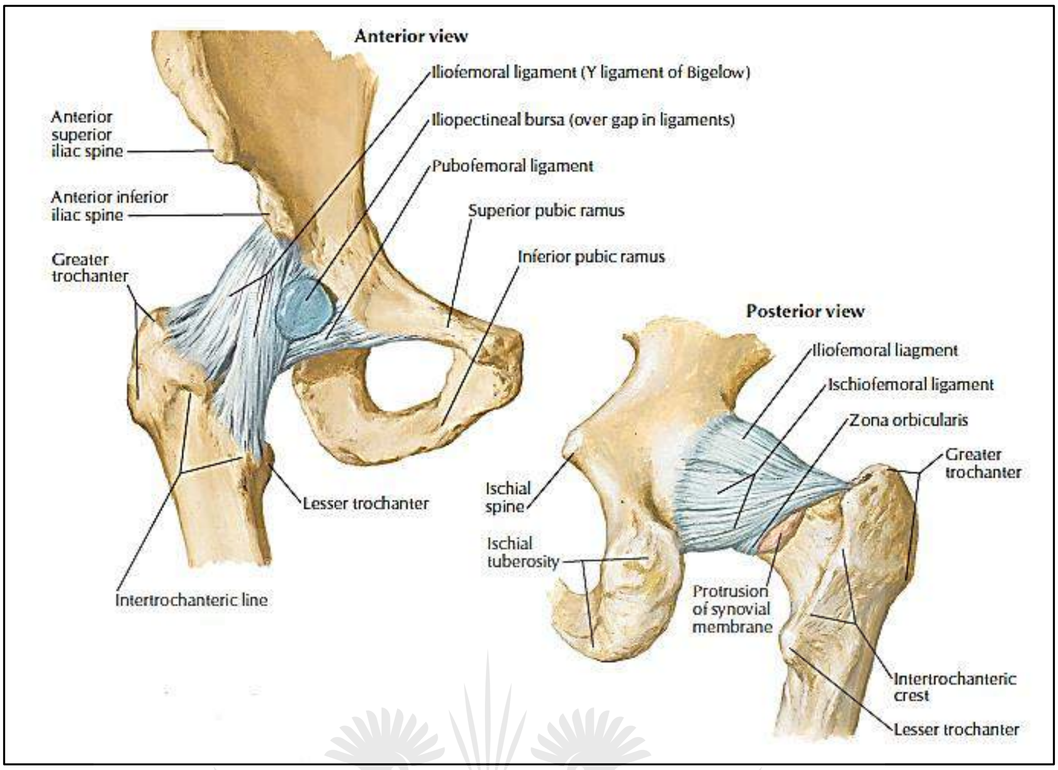

Figure 2.2: Ligaments of the Hip Joint (Netter, 2017)

According to Hewitt et.al (2001), there is a greater incidence of posterior hip dislocations due to the greater thickness of the anterior capsule and we can expect that the anterior capsule elements are stronger than the posterior elements.

The pubofemoral ligament will prevent excessive abduction of the hip joint and limits the degree of extension. All three of the involved ligaments will prevent medial rotation of the femur. The ligamentum teres, which provides attachment of the femur to the acetabulum, also plays a role in the stability of the hip joint (Magee, 2014).

The hip labrum helps to deepen the hip joint and provide further stability to the joint as it increases the articular surface of the acetabulum and creates a seal within the joint. The seal creates negative pressure in the joint which resists the extension of the femoral head from the acetabulum as well as enhancing nutrition by restricting the fluid flow within the joint (Magee, 2014).

The muscles of the thigh are separated by three compartments that pass within the muscle groups i.e. the anterior, medial and posterior compartments. Each compartment is innervated by different nerves and perform different actions on the knee, which is dependent on its location (Moore, Dalley & Agur, 2014).

The anterior compartment consists of the following muscles and are innervated by the femoral nerve. Pectineus, iliopsoas and sartorius form part of the flexors of the hip joint whilst the quadriceps femoris (rectus femoris, vastus lateralis, vastus intermedius and vastus medialis) are responsible for extension of the knee (Table 2.1). Rectus femoris also helps with the stability of the hip joint and aids iliopsoas in hip flexion (Moore, Dalley & Agur, 2014).

Table 2.1: Quadriceps femoris muscles (Marieb, Wilhelm & Mallatt, 2017)

Muscle	**Origin**	**Insertion**	**Action**	**Innervation**
Rectus femoris	Anterior inferior iliac spine and superior margin of acetabulum	Patella and tibial tuberosity via patella tendon	Flexion of hip and extension of the knee	Femoral nerve (L_2-L_4)
Vastus lateralis	Greater trochanter, intertrochanteric line and linea aspera of the femur	Patella and tibial tuberosity via patella tendon	Extension and stabilization of the knee	Femoral nerve
Vastus medialis	Linea aspera, medial supracondylar line, intertrochanteric line of femur	Patella and tibial tuberosity via patella tendon	Extension of the knee; inferior fibres stabilise the patella	Femoral nerve

Vastus intermedius	Anterior and lateral surfaces of the proximal femur	Patella and tibial tuberosity via patella tendon	Extension of the knee	Femoral nerve

The medial thigh compartment (Figure 2.3) is responsible for adduction of the thigh and is innervated by the obturator nerve. Adductor longus, adductor brevis, adductor magnus, gracilis and obturator externus form part of the medial compartment of the thigh (Moore, Dalley & Agur, 2014).

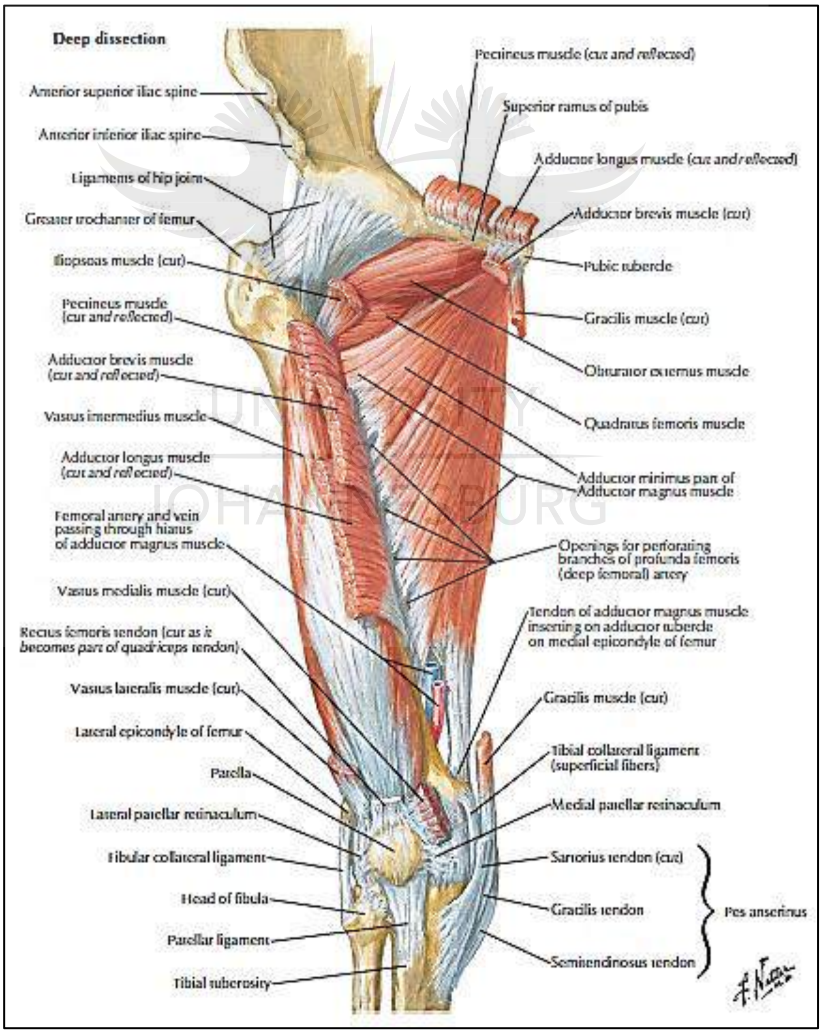

Figure 2.3: Medial compartment of the thigh (Netter, 2017)

The gluteal region is the transitioning zone between the trunk and the lower limb. Physically it is part of the trunk however it is functionally part of the lower limb. The gluteal region consists of the gluteus maximus, gluteus medius, gluteus minimus, tensor fascia latae, piriformis, obturator internus, quadratus femoris, superior and inferior gemelli muscles. The gluteal muscles (Table 2.2) are essential for weight-bearing (gluteus medius and minimus) and rising from a seated position (gluteus maximus) (Marieb, Wilhelm & Mallatt, 2017).

Table 2.2: Gluteal Muscles (Marieb, Wilhelm & Mallatt, 2017)

Muscle	Origin	Insertion	Action	Innervation
Gluteus maximus	Dorsal ilium, sacrum and coccyx	Gluteal tuberosity of femur, iliotibial tract	Extension, lateral rotation and abduction of the thigh	Inferior gluteal nerve (L_5-S_2)
Gluteus medius	Between the anterior and posterior gluteal lines on the lateral surface of the ilium	Lateral aspect of greater trochanter of femur	Abduction and medial rotation of the thigh	Superior gluteal nerve (L_4-S_1)
Gluteus minimus	Between the anterior and inferior gluteal line on the external surface of the ilium	Anterior border of greater trochanter of femur	Abduction and medial rotation of the thigh	Superior gluteal nerve (L_4-S_1)

The posterior thigh region consists of the biceps femoris, semimembranosus and semitendinosus which is also known as the hamstring muscles except for the short head of biceps femoris (Moore, Dalley & Agur, 2014). These muscles have a common origin, insertion, innervation and action (Figure 2.4).

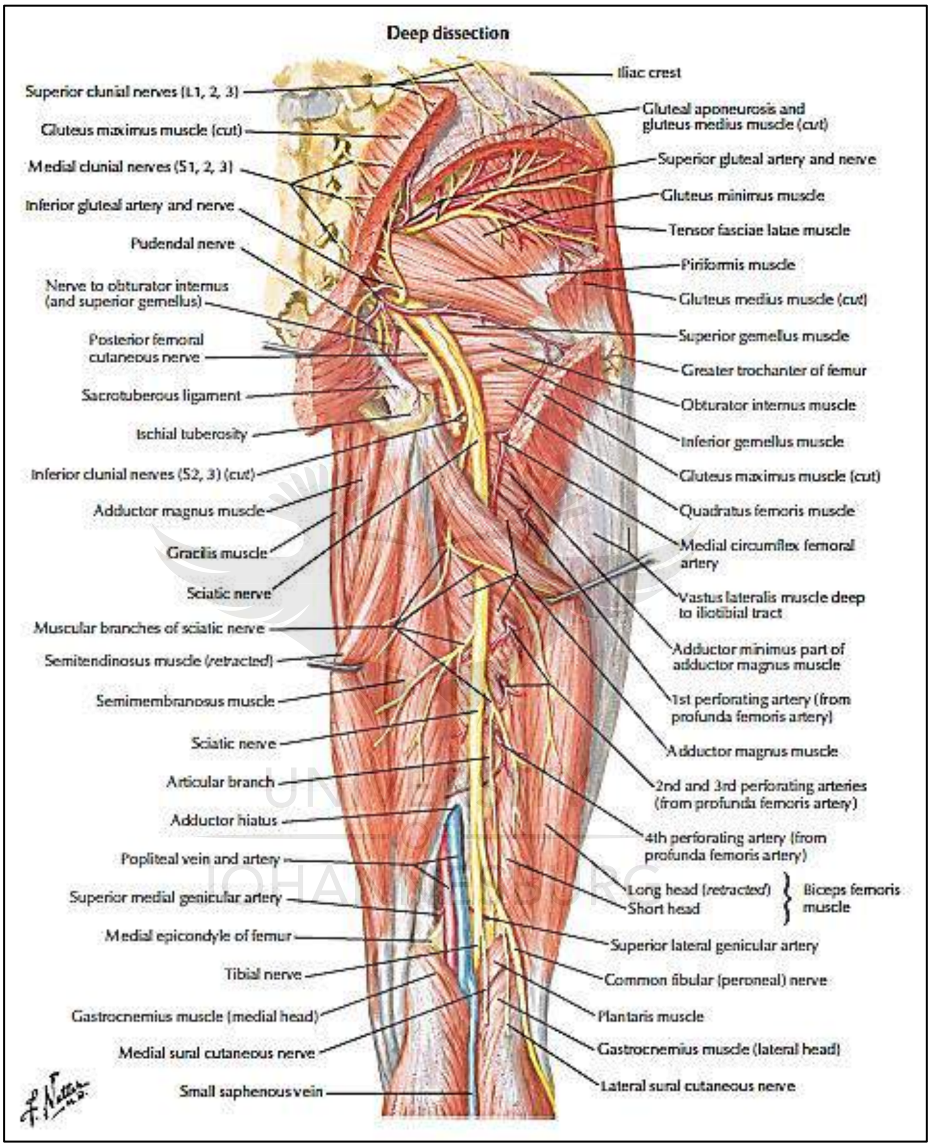

Figure 2.4: Posterior muscles of the thigh (Netter, 2017)

2.2.3 Knee joint anatomy

The tibiofemoral joint is a modified hinge joint with 2° of freedom. There are bursa and pouches around the knee joint. The synovial membrane that surrounds the knee joint does not include the cruciate ligaments as they are extra synovial (Magee, 2014).

The tibia and femur are not congruent with each other which allows for different degrees of movement, as they are guided by the surrounding structures like muscles and ligaments. These two bones only become congruent in the closed packed position i.e. full extension (Moore, Dalley & Agur, 2014).

The menisci that are found within the knee joint aids with the congruency between the tibia and femur. The medial meniscus is C-shaped and is thicker posterior compared to anteriorly. The lateral meniscus is a 0-shape and is equal thickness throughout the structure (Soames and Palastanga, 2019).

From extension to flexion, both menisci move posteriorly. They are avascular in the inner two thirds and partly vascular in the outer third (Magee, 2014). The menisci play in important role in the nutrition, lubrication and shock absorption of the knee; as well as improve weight distribution and joint congruency. Friction can be reduced and prevent hyperextension of the need with the aid of the ligaments and joint capsule.

The patellofemoral joint is a plane joint with the lateral aspect having a larger articular surface. The patella is a sesamoid bone that is found within the patella tendon. During flexion and extension, different parts of the patella articulate with the femoral condyle (Magee, 2014).

In the last 30° of knee extension, the patella improves the efficiency of extension, as it holds the patella tendon away from the axis of movement. The patella is important in guiding the patella tendon during movement; controls the tension in the knee capsule; bony shield for the cartilage of the femoral condyle and improves the appearance of the knee (Magee, 2014).

The superior tibiofibular joint is a plane synovial joint. It is the articulation between the proximal tibia and head of the fibula and supported by the anterior and posterior tibiofibular ligaments. There is only movement of this joint is when there is motion at the ankle (Soames & Palastanga, 2019).

The collateral and cruciate ligaments of the knee (Figure 2.5) are the two sets of ligaments that are responsible for the stability of the knee joint. The cruciate ligaments provide joint stability in the sagittal plane. The anterior cruciate ligament attaches to the anterior aspect of the tibia and runs medial to the medial meniscus. It continues laterally as it runs in a superior and posterior direction to join to the posterior aspect of the lateral condyle of the femur (Soames & Palastanga, 2019)

Posterior displacement of the knee is prevented by the anterior cruciate ligament as it tightens during extension to prevent hyperextension of the knee. When the knee is partly flexed, the anterior cruciate ligament also keeps the tibia from moving anteriorly (Soames & Palastanga, 2019).

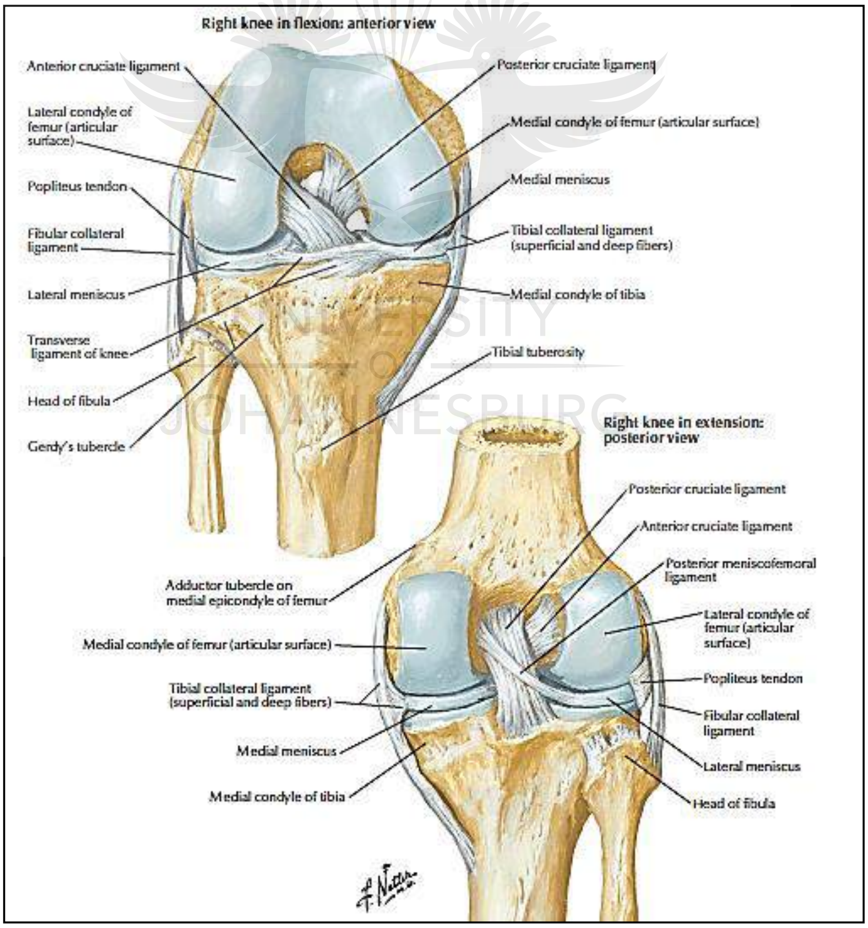

Figure 2.5: Cruciate and collateral ligaments of the knee (Netter, 2017)

The posterior cruciate ligament attaches to the posterior aspect of the tibia and runs between the intercondylar area to run in an anterior and superior direction. It will then attach on the anterior portion of the medial condyle of the femur. The posterior cruciate ligament prevents the anterior displacement of the femur on the tibia as it tightens during flexion (Soames & Palastanga, 2019).

Placed on either side of the knee are the collateral ligaments. The medial collateral ligament attaches to the medial condyles of the femur and the tibia. Medial meniscus fibres also attach to the medial collateral ligament (Lippert, 2006).

The lateral collateral ligament of the knee attaches from the lateral condyle of the femur to insert itself onto the head of the fibula; however, it does not attach itself to the lateral collateral ligament compared to the medial collateral ligament. Medial movement of the knee is protected by the lateral collateral ligament (Lippert, 2006).

These collateral ligaments provide stability for the knee joint in the frontal plane. Due to their orientation and attachment, the ligaments are taut during extension and lax during flexion (Soames & Palastanga, 2019).

The leg of the lower limb is divided into three fascial compartments, namely the anterior, lateral and posterior compartments. According to Moore, Dalley & Agur (2014), the compartments are separated by the anterior and posterior intramuscular septa and the interosseous membrane between the tibia and fibula.

The anterior compartment (Figure 2.6) consists of four muscles namely, tibialis anterior, extensor digitorum longus, fibularis tertius and extensor hallucis longus (Moore, Dalley & Agur, 2014). The muscles pass over the ankle joint which allows these muscles to dorsiflex the ankle, elevate the forefoot and depress the heel. The extensor muscles attach to the dorsal aspect of the digits which results in toe extension. They are innervated by the deep fibular nerve.

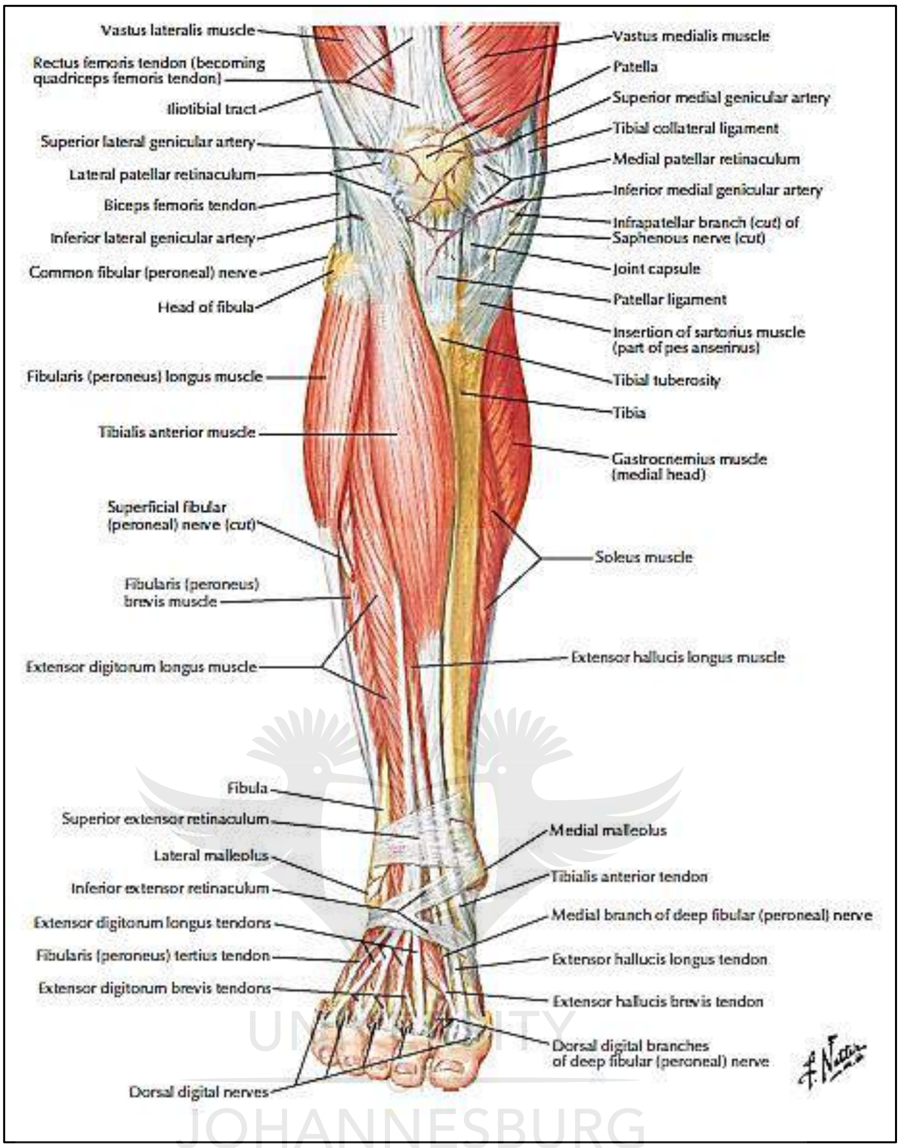

Figure 2.6: Anterior compartment of the leg (Netter, 2017)

The lateral compartment of the leg is also known as the evertor compartment as these muscles evert the foot and has weak plantarflexion action. These muscles are the fibularis longus and fibularis brevis muscles. Both these muscles are innervated by the superficial fibular nerve. (Moore, Dalley & Agur, 2014)

The plantarflexor compartment or the posterior compartment of the leg is subdivided by the transverse intramuscular septa into the superficial and deep subcompartments. The posterior compartment of the leg is responsible for the plantarflexion of the ankle joint; inversion of the subtalar joint and flexion of the toes (Soames & Palastanga, 2019).

The superficial subcompartment of the leg consists of the following three muscles: gastrocnemius, soleus and plantaris. The gastrocnemius and solus muscles are collectively known as triceps surae (Table 2.3) and have a common tendon i.e. calcaneal tendon (Moore, Dalley & Agur, 2014).

Table 2.3: Triceps surae muscles (Marieb, Wilhelm & Mallatt, 2017)

Muscle	Origin	Insertion	Action	Innervation
Gastrocnemius	Two heads from medial and lateral condyles of femur	Posterior calcaneus via calcaneal tendon	Plantarflexion of foot during knee extension; knee flexion during foot dorsiflexion	Tibial nerve (S_1-S_2)
Soleus	Superior tibia, fibula and interosseous membrane	Posterior calcaneus via calcaneal tendon	Plantarflexion of foot	Tibial nerve (S_1-S_2)

According to Moore, Dalley & Agur (2014), there are four muscles that form part of the deep sub compartment of the leg, they are: popliteus, flexor hallucis longus, tibialis posterior and flexor digitorum longus. The flexor muscles in this group will produce flexion of the toes and will assist tibialis posterior in the plantarflexion of the ankle. Popliteus is the only muscle in this group that acts on the knee and is responsible for weak flexion.

2.2.4 Foot and ankle joint anatomy

The foot can be divided into three parts (Lippert, 2006):

- Hindfoot: calcaneus and talus
- Midfoot: navicular, cuboid and three cuneiform bones
- Forefoot: the five metatarsals and all the phalanges

Each part plays a role; the hindfoot has an influence on the function and movement of the rest of the foot as it is the first part that contacts the ground during the gait cycle. The midfoot provides stability and mobility of the foot. The forefoot is responsible for allows the foot to adapt to the ground (Lippert, 2006).

There are three main functions of the foot and ankle (Lippert, 2006):

- Shock absorption during heel strike of the gait cycle
- Adaptation to the different ground terrain
- Proves a stable base of support for the body

The ankle is a synovial joint which is surrounded by a joint capsule. The joint capsule is thin around the anterior and posterior aspects. Reinforcement is then needed which is achieved by the collateral ligaments of the ankle. The deltoid ligaments are found on the medial side of the ankle and are divided into three fibres namely, the tibionavicular, tibiocalcaneal and posterior tibiotalar ligaments (Soames & Palastanga, 2019).

The lateral ligaments of the ankle (Figure 2.7) are also a group of three ligaments namely, the anterior and posterior talofibular ligaments and the calcaneofibular ligament. There are several other ligaments in the foot that connect the tarsal bones to each other and to the metatarsals etc and named according to the bones they are attached too (Lippert, 2006).

There are twenty muscles in the foot where fourteen of which are on the plantar surface, two on the dorsal surface and four in the intermediate position (Moore, Dalley & Agur, 2014). The muscles in the plantar surface are further divided into four layers. These muscles function during the stance phase of the gait cycle as it maintains the arch of the foot during movement; they are also responsible for the stability of the foot.

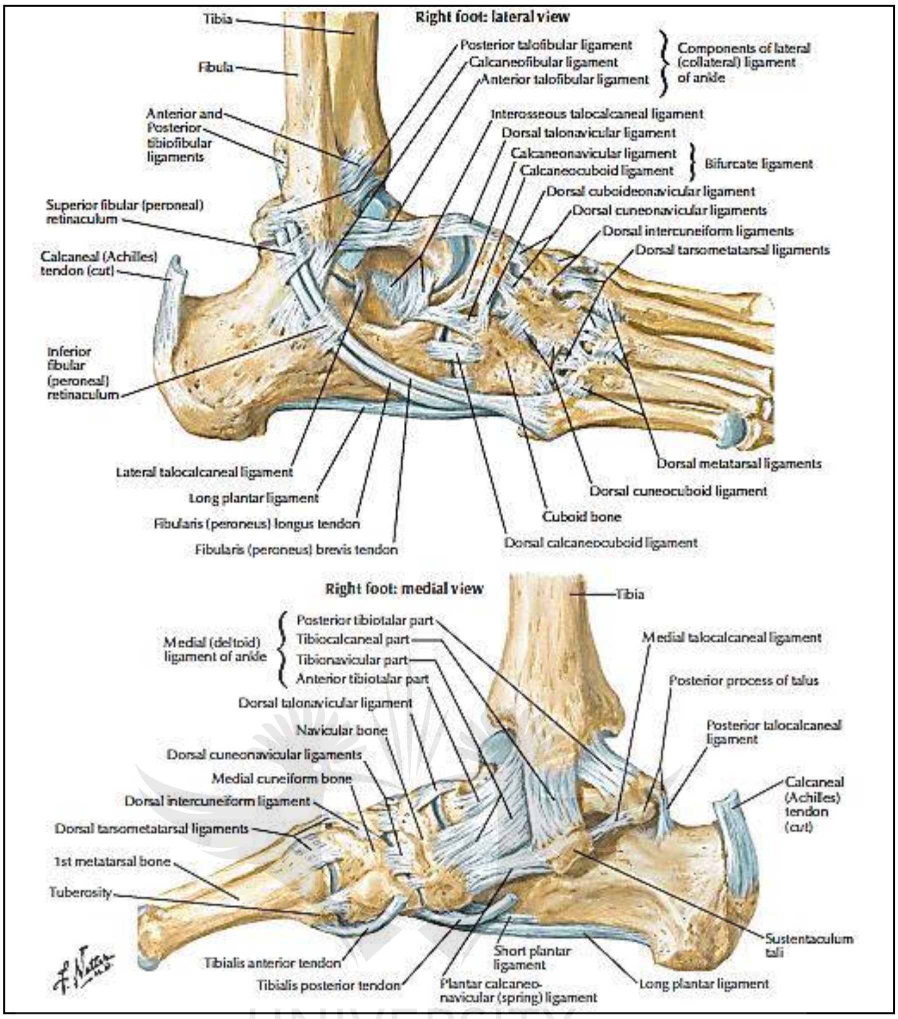

Figure 2.7: Ligaments of the Foot and Ankle (Netter, 2017)

The first layer of the plantar surface of the foot consist of the following muscles: abductor hallucis, flexor digitorum brevis and abductor digiti minimi. The quadratus plantae and the lumbricals make up the second layer of the sole of the foot. The third layer is the flexor hallucis brevis, adductor hallucis and flexor digiti minimi brevis. The fourth layer is the plantar and dorsal interossei muscles (Moore, Dalley & Agur, 2014).

The muscles of the dorsum of the foot are the extensor digitorum brevis and the extensor hallucis brevis (Table 2.4). These two muscles are on the lateral aspect of the foot and can be palpated when the toes are in extension (Moore, Dalley & Agur, 2014).

Table 2.4: Dorsal muscles of the foot (Marieb, Wilhelm & Mallatt, 2017)

Muscle	Origin	Insertion	Action	Innervation
Extensor digitorum brevis	Anterior aspect of calcaneus bone; extensor retinaculum	Base of proximal phalanx of hallux; extensor expansions of toes II-IV	Extend toes at metatarso-phalangeal joint	Deep fibular nerve (L_5-S_1)
Flexor digitorum brevis	Calcaneal tuberosity	Middle phalanx of toes II-IV	Flexion of toes	Tibial nerve, (medial plantar nerve, S_1-S_2)

2.3 Biomechanics

The study of biomechanics is defined as the mechanical principles that directly relate to the human body (Lippert, 2006).

2.3.1 Biomechanics of the pelvis and lower limb

The independent movement of the sacrum and the ilia allows us to walk upright and hold our head relatively stationary. The L5 vertebral body is closely related to the sacroiliac joint, especially during weight bearing, which is why it is included in the biomechanics of the pelvis (Plaugher & Lopes, 1993).

2.3.2 Lumbosacral motion

Lumbosacral motion is the movement between L5 and the sacrum. The L4-L5 intervertebral disc acts as a hinge during lateral flexion and rotation movement between L5 vertebral body and the sacrum. These movements are controlled by the coronally orientated facet joints and the iliolumbar ligament. However, during flexion and extension, the intervertebral disc of L5-S1 acts as a hinge (Plaugher & Lopes, 1993).

If the sacrum moves anteriorly and inferiorly, with the ilia, the L5 vertebral body will rotate in the opposite direction due to the restraints of the iliolumbar ligament (Plaugher & Lopes, 1993).

2.3.3 Biomechanics of the sacroiliac joint

According to Bergmann and Peterson (2011), the sacroiliac joint is most active during movement, mainly in the oblique sagittal plane. During movement, the sacroiliac joint flexes and extends in conjunction with the ipsilateral hip joint. In the gait cycle, the sacroiliac joint undergoes two cycles of altering flexion and extension. There is a mirrored movement between the two sacroiliac joints during flexion and extension.

2.3.4 Nutation and counternutation

Nutation (Figure 2.8) is defined as the motion of the sacrum that moves along the coronal axis (in the sagittal plane) in which the sacral base moves anterior and inferiorly simultaneously with the tip of the coccyx moving posterior and superiorly (Bergmann & Petersen, 2011).

During nutation or sacral flexion, the pelvic outlet becomes larger. The pelvic outlet is described as a line from the tip of the coccyx to the inferior surface of the pubic symphysis (Lippert, 2006).

Counternutation is defined at the motion of the sacrum that moves along the coronal axis (in the sagittal plane) in which the sacral base moves posterior and superiorly simultaneously with the coccyx moving anterior and inferiorly (Bergmann & Petersen, 2011).

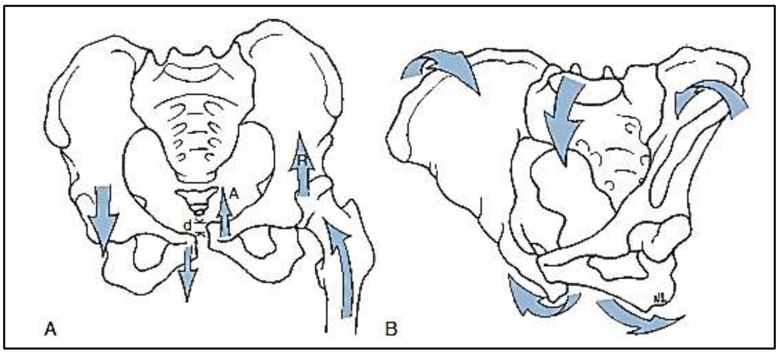

Figure 2.8: Nutation of the sacral base and extension of the lumbosacral articulation (Bergmann & Petersen, 2011)

According to Lippert (2006), counternutation or sacral extension is when the pelvic inlet becomes larger. The pelvic inlet is described as a line from the base of the sacrum to the superior side of the pubic symphysis.

Nutation and counternutation occur when the truck is in flexion or extension when changing from certain positions like sitting, standing upright and the recumbent position. These movements are termed flexion and extension because it describes the lumbosacral articulation and not the sacroiliac joints (Bergmann & Petersen, 2011).

2.3.5 Biomechanics of the hip joint

The main role of the hip joint is to support the weight of the trunk, arms and head during daily activities. The hip joints allow for the transfer of forces between the upper body and the lower limbs which is essential for normal body functioning. The shape of the ball-and-socket joint allows for adequate mobility for movement and balance (Nordin & Frankel, 2012).

There are three planes of motion in the hip joint (Figure 2.9): sagittal (flexion and extension), frontal (abduction and adduction) and transverse (internal and external rotation). There is greater motion in the sagittal plane where flexion is 0°-140° and extension being 0°-15°. Adduction range of motion is less than abduction i.e. 0°-25° compared to the 0°-35° of abduction. When the hip is flexed, it allows for more range of motion in external rotation (0°-90°) and internal rotation (0°-70°) in comparison to when the limb is in extension due to soft tissue limitations (Nordin & Frankel, 2012).

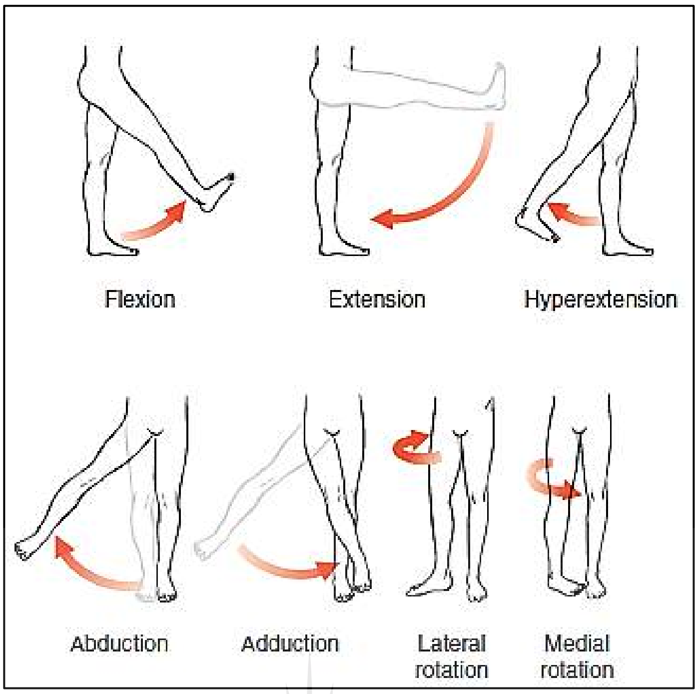

Figure 2.9: Movement of the hip joint (Lippert, 2006)

Measurements performed revealed that in the sagittal plane the hip joint is in full flexion during the late swing phase of the gait cycle as the limb moved forward into heel-strike for the stance phase. The joint will then transition into extension when the stance phase begins and ending off in maximum extension at heel-off (Samuels, 2018).

Abduction is at the maximum point just after toe-off with adduction being optimal at heel-strike which lasts until late stance phase. During the stance phase, the hip joint is internally rotated and as it transitions into the swing phase, it reverses into external rotation (Nordin & Frankel, 2012).

2.3.6 Biomechanics of the knee joint

The knee joint helps to convey forces and aid with the position and movement of the body during motion. It also facilitates the conservation of momentum and provides the necessary instant for activity that will involve the leg. The knee does have to sustain high forces as it is between the body's two longer level structures, i.e. tibia and femur, which makes is susceptible to injury (Nordin & Frankel, 2012).

According to Nordin and Frankel (2012), the range of motion in the knee will occur in the three planes with most of the motion in the sagittal plane. The quadriceps muscle dominates the knee movement at any given time during motion as it exerts a lot of muscle force on the joint.

The sagittal plane has the greatest range of motion in the tibiofemoral joint which ranges from 3° of hyperextension (-3° flexion) to 155° flexion (Figure 2.10). The thigh to calf tissue contact is the reason for the limited range of flexion in the knee (Nordin & Frankel, 2012).

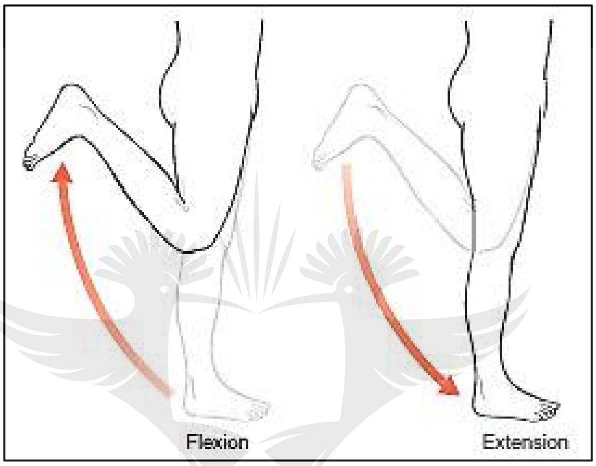

Figure 2.10: Flexion and extension of the knee joint (Lippert, 2006)

The range of motion in the transverse plane, i.e. internal and external rotation, is dependent on the laxity of the surrounding structures which support the knee when going into the extremes of the range of motion (Samuels, 2018).

When the knee is in full extension, the degree of internal and external rotation is limited due to the interlocking of the femoral and tibial condyles. This can be further explained as the medial condyle is longer than the lateral condyle with the collateral ligaments, posterior joint capsules and the anterior cruciate ligament tightening during this movement (Samuels, 2018).

When the knee is at 30°-40° of flexion, it is in the open packed position which allows for the maximum range of internal and external rotation. External rotation at this point is approximately 18° whilst internal rotation will be at approximately 25° (Nordin & Frankel, 2012).

Motion in the frontal plane, i.e. abduction and adduction, is also affected by the amount of knee flexion. When the knee is in full extension, it prevents the movements in the frontal plane. Passive abduction and adduction will increase when the knee is at 30° of flexion. As the knee increases in flexion, the range of motion in the frontal plane will start to decrease which is due to the soft tissue limitations (Nordin & Frankel, 2012).

Abduction is greater than adduction in flexion and this is due to the increased stiffness of the medial collateral ligament in comparison to the lateral collateral ligament (Nordin & Frankel, 2012). When the knee is functioning in motion, the movement in the frontal plane is prevented by the axial forces and the muscle activity surrounding the knee, which aids with the stability (Samuels, 2018).

2.3.7 Biomechanics of the foot and ankle joints

The foot and ankle's primary function is to provide a stable, efficient and adaptable crossing point between the body and the ground for movement. This task requires the foot and ankle to be pliable to adapt to different terrains to translate and absorb forces during the gait cycle whilst keeping the body stable. The structures must also be rigid during the late stance phase to move the body forward using the rigidity of the longitudinal arch of the foot (Samuels, 2018).

The main movements of the ankle are dorsiflexion and plantarflexion which occurs in the transverse plane (Figure 2.11). In the foot, flexion and extension occurs at the metatarsophalangeal and interphalangeal joints. Inversion is produced by flexion of the toes and when the toes are extended, the foot is in eversion which is shown in Figure 2.11 (Moore, Dalley & Agur, 2014).

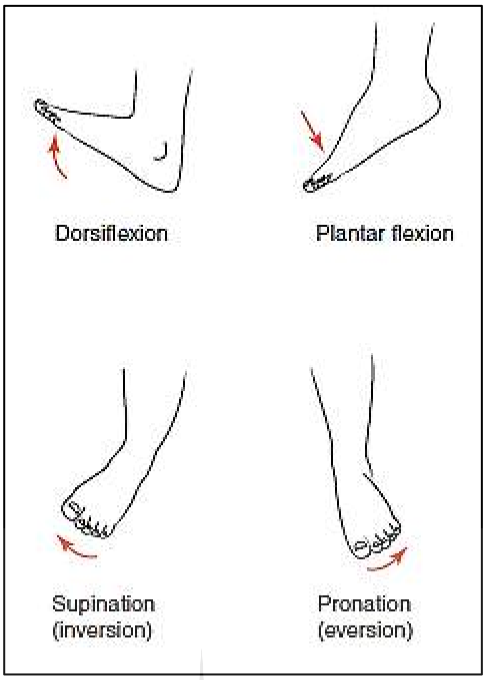

Figure 2.11: Ankle joint and foot motion (Lippert, 2006)

During normal walking, the lower limb will internally rotate during the first phase of the stance phase i.e. heel-strike and flat foot. The subtalar joint will evert while the foot will pronate to allow for shock absorption as the foot encounters the ground. The forefoot will become flexible to allow for adaptation to the terrain. During the last stages of the stance phase, the lower limb will start to externally rotate while the subtalar joint will invert with foot supination. The forefoot will now become a rigid structure to allow the limb to propel itself forward (Nordin & Frankel, 2012).

At heel-strike in the stance phase, the ankle will be in plantarflexion to prepare for contact into the ground. Plantarflexion will then further increase as it progresses in the stance phase to foot flat. Thereafter, the motion of the ankle joint will decrease as it reverses into ankle dorsiflexion at midstance when the body passes over the foot. At the end of the stance phase, the ankle will be in plantarflexion again when it ends at toe-off (Nordin & Frankel, 2012).

According to Nordin and Frankel (2012), during the swing phase, the ankle will start in plantarflexion in the initial swing. As the limb moves into mid swing, the ankle will be dorsiflexed to allow for clearance with the ground. The terminal swing will end off in plantarflexion to prepare the ankle for the start of the stance phase again. During normal walking, the ankle motion has an average range of 10.2° dorsiflexion and 14.2° plantarflexion.

2.4 Sacroiliac Joint Dysfunction

According to Ilaslan, Arslan, Koc, Dalkilic and Naderi (2010), sacroiliac joint dysfunction is one of the causes for non-discogenic lower back and groin pain. This has a similar pain pattern to disc herniation, lumbar stenosis and lumbar facet syndrome.

2.4.1 Aetiology of sacroiliac joint dysfunction

Pain in the sacroiliac joint may arise from various aetiologies but there is no clear predisposition to the condition. Several factors may contribute to the progression of sacroiliac joint dysfunction such as; degenerative joint disease, joint laxity and trauma. It's important to note that the stage of degeneration does not directly correlate with the clinical symptoms (Zelle, Gruen, Brown, & George, 2005).

According to Zelle et al (2005), minor direct trauma caused by falling on the buttocks can lead to the development of Sacroiliac Joint Dysfunction. It was noted that there is a higher prevalence in women due to ligament laxity during pregnancy.

2.4.2 Signs and symptoms of sacroiliac joint dysfunction

Pain that is generated in the sacroiliac joint or any of the surrounding structures can present as lower back pain, pelvic pain, sacral pain or gluteal pain. There may be associated numbness, popping, clicking or groin pain. The pain can be bilateral or unilateral, with unilateral being more common in a ratio of 4:1, according to Foley and Buschbacher (2006).

Unilateral pain is more common due to unilateral loading, especially in athletes that require kicking or throwing as the weight will be transferred onto the favoured leg/side. 44-58% of people who present with sacroiliac joint pain will have a history of trauma to the area (Foley & Buschbacher, 2006).

Research conducted by Laslett (2018), stated that there was no difference found in the range of motion between the symptomatic and asymptomatic side of the sacroiliac joint pain. Pain is also provoked upon palpation in people who may have asymptomatic sacroiliac dysfunction.

2.5 Gait

2.5.1 Introduction

Gait is the voluntary movement of the body that involves a process between the brain, spinal cord, nerves muscles, joints and bones; all these components need to be intact and at the optimal function for walking (Whittle, 2007). Walking entails the repetitive cycle of limb movement to propel the body forward while also aiming to maintain postural stability (Perry & Burnfield, 2010).

The gait cycle refers to the sequence of movement of one limb, which can be divided into two phases, namely: stance and swing. The stance phase is the term used when the foot is on the ground and starts with the initial contact of the heel. Swing phase occurs when the foot is in the air to propel the limb forward and starts when the toe is lifted off the ground i.e. toe off (Perry & Burnfield, 2010).

The body is subdivided into two units, the passenger unit and the locomotor unit when considering gait. The head, neck, trunk and arms form part of the passenger unit as they indirectly play a role in the act of walking. This complex contributes to the centre of gravity as it maintains the neutral posture and alignment of the spine.

Components that form the locomotor unit is the two lower limbs and the pelvis as they are actively involved in the gait cycle. When looking at the locomotor unit, we need to consider the eleven joint articulations and fifty-seven muscles that are involved in the movement. The pelvis is a mobile link between the two lower limbs in the locomotor unit but also the base segment for the passenger unit that articulates with the hip joints (Perry & Burnfield, 2010).

2.5.2 Gait cycle

When analysing the gait cycle, it is divided into two phases namely, swing and stance phase (Figure 2.12). The gait cycle is initiated by heel strike which is the beginning of the stance phase and a gait cycle is complete when the same foot hits heel strike again (Samuels, 2018).

During one gait cycle, one limb passes through these two phases:

- Stance phase: This phase is 60% of the gait cycle and is initiated when one foot on the lower limb hits heel strike and ends when that same lower limb reaches toe-off. During the stance phase, the foot is weight bearing as it is in contact with the ground (Samuels, 2018).
- Swing phase: This phase is 40% of the gait cycle and begins when the same lower limb leaves the ground at toe off and ends just before the lower limb hits heel strike. The foot is now non-weight bearing as it has no contact with the ground and is propelling the body forward (Samuels, 2018).

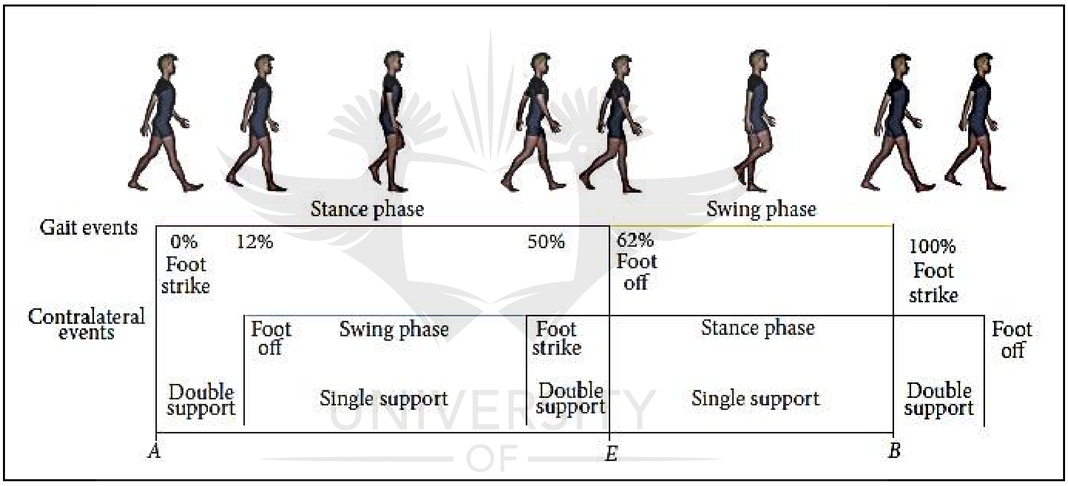

Figure 2.12: Gait cycle (Iosa, Fusco, Marchetti, Morone, Caltagirone, Paolucci & Peppe, 2013)

It's important to note that the above-mentioned phases are further divided into different events. The stance phase is divided into four sub-phases (Levangie & Norkin, 2005):

- Heel strike/Initial contact – this is the initial contact where the foot strikes the ground. There is double support as the contralateral leg is now in the toe off phase
- Full forefoot load/ Foot flat – the foot is now fully in contact with the ground and the lower limb now starts to hold the weight of the body

- Midstance – this is the point where the body weight is now precisely over the stance leg. This begins when the contralateral/ swing leg lifts off the ground and now progresses ahead of the stance leg
- Heel lift/ Heel off/ Terminal stance - this is when the heel of the stance leg leaves the ground and the unloading of the weight onto the contralateral leg
- Toe off/ Pre-swing – the toe of the stance leg is only in contact with the ground and will now progress into the swing phase of the gait cycle. This is the second double support in the gait cycle as the contralateral leg is in the heel strike phase

After the toe off in the stance phase, the swing phase begins. This phase is then divided into three sub-phases (Levangie & Norkin, 2005):

- Initial swing – this starts the moment the toe of the stance leg lifts off the ground and the leg is now referred to as the swing leg. There are maximal knee flexion and ankle dorsiflexion to allow the limb to accelerate forward
- Mid swing – the swing leg now passes beneath the body and there is maximum knee flexion. The leg is now adjacent to the weight bearing leg (which would be in midstance)
- Terminal swing – the knee starts to extend to prepare for the heel to meet the ground which will then start the stance phase again. The lower limb starts to decelerate and propel the body forward.

The gait cycle can be further analysed into time and distance variables that can be measured. This includes:

Temporo-spatial variables (Richards, 2018):

- Stance time: the period it takes during the stance phase of one lower limb in the gait cycle.
- Single-support time: the period during the gait cycle when only the supporting leg is in contact with the ground.
- Double-limb support time: the period that elapses where both feet are on the ground during one gait cycle as the stance phase of one limb overlaps with the stance phase of the contralateral limb; it is inversely proportional to the speed of walking.

- Stride time: the time that is taken to complete one stride. Stride time and gait cycle duration are the same.
- Step time: the time spent during a single step which is measured in seconds per step.
- Cadence: the number of steps taken by a person per minute or per second.
- Walking velocity: the rate of linear forward motion of the body.
- Acceleration: the rate of change of velocity over time.
- Speed: referred to as either fast or slow. A fast gait speed correlates with increased cadence and stride length with a decreased angle of toe out. Walking speed is determined by step length x step rate.

Distance variables (Levangie & Norkin, 2005):

- Stride length: the displacement between two consecutive events that is completed by the same lower limb during gait. This is measured from the point of heel strike of one lower limb to the next heel strike of the same lower limb. A full stride includes two steps i.e. one right step and one left step.
- Step length: the displacement between two consecutive heel strikes. Measured from heel strike of one lower limb to the heel strike of the opposite lower limb.
- Step width: this is determined by calculating the displacement between the midpoint of the heel of one foot and the equivalent point on the other foot.
- Foot rotation/ degree of toe out: this is the angle of foot placement away from the line of progression. It is calculated by measuring the angle formed by each foot's line of progression and a line overlapping the centre of the heel and the second toe. The angle is approximately 7%.

2.5.3 Pelvic kinematics during gait

The pelvis has a small degree of anterior and posterior tilt in the sagittal plane. The posterior tilt will occur at beginning of the gait cycle during the double support phase. Anterior tilt will occur when the gait cycle is on the single support phase of the one limb. At the end of stance phase, the pelvis tilts posteriorly just after toe-off (Samuels, 2018).

In the frontal plane, the pelvis will rotate 10°-15° due to the hip abduction and adduction. As the weight shifts onto the opposite leg, the ipsilateral iliac crest will move inferiorly, and the contralateral side is in hip adduction. The ASIS will then move anteriorly in the horizontal plane (Samuels, 2018).

2.5.4 Hip kinematics during gait

At the initial contact of the foot, the hip is in flexion at 30° in the sagittal plane. As the body progresses over the foot, the hip then moves into 10 ° of extension by heel off in the gait cycle. Hip flexion starts again in the swing phase and reaches a maximum of 30° before the foot meets the ground (Samuels, 2018).

While the pelvis rotates during the gait cycle, the hip will move in the horizontal plane. When the limb starts its initial contact, the ipsilateral hip will be in lateral rotation while the contralateral ASIS is in posterior rotation (Richards, 2018).

2.5.5 Knee kinematics during gait

According to Samuels (2018), at the initial contact the knee will be flexed at approximately 5° and will go into further flexion as the foot meets the ground. The flexion assists with weight acceptance as the limb becomes weight bearing thus allowing for shock absorption. As the stance phase progresses, the knee will go into extension but then reverse back into flexion as the heel starts to lift off the ground. At toe-off the knee will be at 35° of flexion but will continue to flex to 65° at mid-swing during the gait cycle.

2.5.6 Ankle kinematics during gait

The talocrural joint will be between 0°-5° of plantar flexion at the initial contact of the foot to the ground. The ankle will then be in dorsiflexion to lower the foot onto the ground (Richards, 2018). The ankle will then progress to 10° of dorsiflexion as the tibia moves over the foot but then plantar flexion will occur during heel rise, reaching 15°-20° at toe off (Samuels, 2018).

2.6 Biomechanical Pelvic Blocking

2.6.1 Introduction

Biomechanical pelvic blocking was derived from the Sacro-Occipital Technique which was founded by Major Bertrand DeJarnette and the pelvic blocks were introduced in 1962 (Cooperstein & Gleberzon, 2004).

According to Cooperstein and Gleberzon (2004), the padded wedges are used as a fulcrum to correct the intrapelvic torsion. DeJarnette believed that the innominate bones could be balanced. This would result in the balance of the sacrum as it forms part of the pelvic kinematic chain.

If there is a pelvic torsion dysfunction, it will interfere with the pelvic complex which is responsible for the weight-bearing stability from the posterior sacroiliac ligaments; the anterior fibres of the sacroiliac joint are associated with the craniosacral respiratory system and for the normal lumbosacral motion (Cooperstein & Gleberzon, 2004).

Biomechanical pelvic blocking is a method of treatment used to correct the alignment of the pelvis. The placement of the blocks underneath the pelvis is determined by the functional long leg as well as the pelvic torsion. There are no known contra-indications as this treatment is non-invasive and effective (Hartley, 2005).

Pelvic blocking is a procedure when a pair of padded wedges is placed under a patient's pelvis for a various amount of time. Each wedge is placed under each hemipelvis, while the patient is lying either prone or supine, in a position which is appropriate for the patient's condition (Gatterman, Cooperstein, Lantz, Perle & Schneider, 2001).

Placement of the biomechanical blocks underneath the pelvis serves as a fulcrum that will apply a gravitational force on the sacroiliac joint. Prone blocking aims to mobilize the sacroiliac joint. The biomechanical blocks have an angle of inclination of 45° to change the forces applied to the sacroiliac joint (Giggey & Tepe, 2008).

Pelvic blocking can either be performed in the prone (Figure 2.13) or supine position (Figure 2.14). While placing the blocks in the prone position, the innominate bones will be raised in comparison to the sacrum; thus, distracting the sacroiliac joint. Comparatively, supine pelvic blocking will elevate the innominate bones relative to the sacrum. Therefore clinically, the prone position allows for mobilization and the supine position achieves stabilization of the lower back (Cooperstein & Lisi, 2004).

Figure 2.13: Prone pelvic blocking (Cooperstein & Lisi, 2004)

Figure 2.14: Supine pelvic blocking (Cooperstein & Lisi, 2004)

Noizadan (2006) had conducted a study comparing a spinal manipulation technique with biomechanical pelvic blocking on sacroiliac dysfunction. His findings showed that both techniques influenced the sacroiliac joint but neither technique was more superior to the other. Another study was conducted by Schooling et.al (2012) on the immediate effects of chiropractic sacroiliac joint manipulation on gait and showed a statistical significance in the gait parameters.

2.6.2 Advantages of biomechanical pelvic blocking

The following are benefits of pelvic blocking:

- Blocks can perform the function of adjusting both innominate bones at the same time (Noizadan, 2005).
- They are non-traumatic to the patient and can be used with all ages including acute sacroiliac sprains/strains (Noizadan, 2005).
- Blocks can be used in patients who are contraindicated for high force adjusting in the side lying position. This technique is very beneficial with acute and frail patients where low force methods are indicated (Cooperstein & Gleberzon, 2004).
- Patient will be in a relaxed recumbent position compared to the tense posture experienced when they are side lying (Noizadan, 2005).
- There are no known contraindications to blocking compared to adjusting; it can also be used on osteoporotic and arthritic patients (Cooperstein & Gleberzon, 2004).
- Pelvic blocking adjusts the anterior and posterior as well as the internal and external misalignment simultaneously (Noizadan, 2005).
- The blocks can be used for disc lesions, facet syndromes and other lower back conditions where the blocks are placed on either the anterior or posterior innominate with traction applied to the area (Cooperstein & Gleberzon, 2004).
- This technique can be used on patients of any size without causing difficulty (Noizadan, 2005).
- "Orthopaedic blocking" can be used in the shoulder or the spine which can be used for scoliosis and other specific conditions (Noizadan, 2005).
- Placement of the blocks provides control for the spinal muscles which allows them to relax and decrease spinal deviations; in turn calming the proprioception response thus reducing pain (Noizadan, 2005).
- There is a muscle stretching effect as the blocks allow for slow stretching of the muscles (Noizadan, 2005).

2.7 Conclusion

The anatomy and biomechanics of the lower limb is intricate and vital in the gait cycle. Each structure plays its own role in keeping the body stable and allowing for the body to be propelled forward. Biomechanical pelvic blocking is not a common technique used by chiropractors as there is limited research available. It can be beneficial to patient care as its low force approach is suitable for all patients.

CHAPTER 3 : METHODOLOGY

3.1 Introduction

The aim of this study was to determine whether biomechanical pelvic blocking had an immediate effect on the parameters of gait.

This chapter aids to describe how participants in this study were selected, physically examined, treatment procedures, how data was obtained as well as any relevant test that were used and the analysis of data.

3.2 Study Design

This is a single intervention quantitative study with random group allocation.

3.3 Sample Selection and Criteria

One hundred participants between the ages of 18 and 30 years old were enlisted for this study by advertisements placed around the University of Johannesburg (Appendix A) or by word of mouth. Participants that agreed to be part of the study were randomly allocated to either one of two groups.

3.3.1 Inclusion criteria

To be involved in the study, all the participants would have had to meet the following requirements:

- Participants had to be between the ages of 18 to 30 years old
- Male and female participants were both included
- Upon physical assessment, participants had to present with a sacro-iliac restriction.

3.3.2 Exclusion criteria

If participants presented with the following, they were excluded from the study:

- Participant had a history of hip, knee or foot pathology
- Previous surgery on the hip, knee, foot or ankle as this may change the biomechanics of the gait patterns
- Structural leg length discrepancy/inequality
- Wears orthotics

- Has recently been treated by a chiropractor or podiatrist for any condition in the last 6 months.

3.3.3 Random group allocation

Participants were randomly selected which formed part of the University of Johannesburg or the public. If they agreed to participate in the study and met the inclusion criteria, they were asked to pick a letter out of a hat. They were allocated to either Group A or Group B. Group A received treatment with biomechanical pelvic blocking according to their sacroiliac assessment and findings. Group B, the control group, did not receive any treatment. Each group had fifty participants.

3.4 Methodology

A hundred participants between the ages of 18 and 30 years old were recruited on a voluntary basis. They were informed about the study (Appendix C) and signed a consent form (Appendix D). A full case history (Appendix E) was taken initially to ensure that the participant fulfilled the criteria for the study. The participants were then analysed on the Zebris FDM gait analysis system for their initial gait reading (Appendix B).

A physical examination (Appendix F), lumbar spine and pelvic regional examination (Appendix G) were performed after the initial gait reading to prevent any changes to the anatomy and biomechanics that would have occurred with the examination. Thereafter, participants received treatment with the biomechanical pelvic blocks for 8 minutes, if they were part of Group A, according to their sacroiliac joint restrictions which was recorded in the SOAP (subjective, objective, assessment and plan) note (Appendix H). Participants in the control group i.e. Group B, they did not receive treatment, but they had a rest period in the prone position for 8 minutes. All participants were then required for a subsequent analysis on the Zebris FDM gait analysis system. Only one visit was required as this was a single intervention study.

3.4.1 Orthopaedic tests for sacroiliac joint dysfunction

The following four examinations were performed to determine whether there was a Sacroiliac Joint Dysfunction:

- **Gaenslen's Test**

Patient was lying supine with the tested side near the edge of the examination table. They were then instructed to pull both knees towards their chest; thereafter they were required to extend the tested leg over the edge of the table into a hyperextended position. The examiner then applied extra pressure by pushing the tested leg into further extension and the contralateral leg into further flexion. The test was then repeated on the opposite side. A positive for this test was pain which indicated a sacroiliac lesion, hip pathology or L4 nerve root lesion (Magee, 2014).

- **Patrick Faber's Test**

The patient was lying supine on the examination table and the examiner then placed the patient's tested leg so that the foot of the tested leg was on top of the knee of the contralateral leg. The examiner then slowly lowers the knee of the tested leg towards the table. A positive test was indicated when the knee of the tested leg was above the level of the opposite straight leg. If it was positive, the test then indicated that there may be a hip joint pathology, iliopsoas spam or sacroiliac joint involvement (Magee, 2014).

- **Yoeman's / Erichsen's Test**

The patient was lying prone with the examiner standing on the opposite side of the tested leg. The examiner then placed one hand on the posterior superior iliac spine (PSIS) of the tested side and then placed the other hand underneath the tested legs knee. The examiner then lifted and extended the patient's hip with the knee extended whilst applying a posterior to anterior pressure on the posterior inferior iliac spine (PSIS). Pain that was local to the sacroiliac joint indicated that there was pathology in the anterior sacroiliac ligaments (Magee, 2014).

3.4.2 Motion palpation of the sacroiliac joint

- **Gillet's Test**

Patient was required to stand while the examiner palpates the posterior superior iliac spine (PSIS) with one thumb and the other thumb is parallel to it and placed on the sacrum in the midline. The patient was then instructed to flex the tested leg towards their chest while standing on the contralateral leg. This movement caused the innominate bone on the tested side to rotate posteriorly. The test was then repeated on the opposite side by palpating the opposite PSIS. A positive test was if the tested side revealed minimal movement or felt “blocked” to the examiner (Magee, 2014).

- **Standing Flexion Test**

The patient was standing with the examiner behind them. The examiner then palpated the PSISs on both sides and instructed the patient to forward flex. A superior movement of the one PSIS compared to the other indicates a positive test. This indicates that there is limited movement of the ilium relative to the sacrum which results in limited sacroiliac joint motion on the side that moves more superiorly (Cibulka & Koldehoff, 1999).

- **Piedallu’s Sign/ Sitting Posterior-Superior Iliac Spine Palpation**

The patient was asked to sit on the examination table which was hard and flat; this position prevents the muscles (e.g. hamstrings) from affecting the pelvic flexion symmetry and increased the stability of the ilia. The examiner then palpated both PSISs and compared their heights relative to each other. If one PSIS, which is usually the painful one, is lower than the other side, the patient was then asked to forward flex whilst they are seated. If the lower PSIS became higher than the opposite side during forward flexion, the test is then positive on the side it was affected (Magee, 2014). This was due to the affected joint not being able to move properly and was hypomobile. It indicated an abnormal torsion movement of the sacroiliac joint (Cibulka & Koldehoff, 1999).

3.5 Treatment Approach

Participants only required one session of treatment for this study and only fifty participants that were placed in Group A were treated. Participants in Group B were required to be in the prone position for 8 minutes as they were part of the control group.

3.5.1 Biomechanical pelvic blocking

The lumbar spine and pelvic regional examination would have been performed on each participant and their sacroiliac joint restrictions were noted using the motion palpation techniques. The biomechanical pelvic blocks were placed according to the following listings (Bergmann & Peterson, 2010):

- In relation to the sacrum, the innominate was fixed in extension where the posterior superior iliac spine was in an anterior superior position (AS). On this side of the ilium, there was a long leg or a longer functional leg length discrepancy
- In relation to the sacrum, the innominate was fixed in flexion where the posterior superior iliac spine was in a posterior inferior position (PI). On this side of the ilium, there was a short leg or shorter functional leg length discrepancy

Participants were placed prone with a firm surface underneath the pelvis. Pelvic wedges/blocks were then placed under the anterior superior iliac spine on the AS ilium side and under the greater trochanter of the femur on the PI ilium side. No thrust was necessary for this technique as gravity provided the force over time. The treatment time varies from 5-8 minutes according to literature (Bergmann & Petersen, 2011), but for the study, participants were treated for 8 minutes.

3.6 Objective Data

3.6.1 Zebris FDM Gait Analysis System

The Zebris FDM gait analysis system was used to measure the parameters of gait i.e. stride length and step width; stance and swing phase as well as the double-support phase; and, the cadence. The variability of the gait velocity was calculated as a measure for postural instability (Giacomozzi, 2010).

The measuring plate (Figure 3.1) was installed with several high-quality force sensors to calibrate the information, whether static or dynamic, and analyse it according to its parameters. The plate is installed in the same level as the floor to ensure that the walking pace was constant and smooth for accurate measurements.

The information is calculated by the WinFDM program and a report (Appendix B) is printed.

All participants were analysed before and after their treatment or rest period with the Zebris FDM gait analysis system to measure all their gait parameters. They were required to walk over the measuring plate, at their normal pace, 6 times to gain readings.

A study on the reliability of spatiotemporal and kinetic parameters determined by the Zebris FDM gait analysis system was carried out and proved to be reliable when detecting the parameters of gait (Reed, Urry & Wearing, 2013).

Figure 3.1: Zebris FDM Gait Analysis System (Zebris Medical GmbH, 2016)

3.7 Data Analysis

All relevant data was gathered by the researcher during the study. The collected data was then tabulated and analysed with the assistance from the statistician at STATKON (locate at the University of Johannesburg Kingsway Campus, Auckland Park)

Data readings that were generated by the Zebris FDM Gait Analysis System were recorded and tabulated on the IBM SPSS Statistics 25 program. The analysis included descriptive statistics. Kolmogorov-Smirnov Test was used to check the normality of the variables.

For intra-group analysis, Paired Samples T-tests was used; this was performed to check if there were statistically significant changes between the two time periods (pre and post treatment), depending on the normality of the test.

Inter-group analysis included the Independent T-tests to check for statistically significant differences between the two groups depending on the outcome of the normality test.

3.7.1 Paired samples t-test

The paired t-test is a parametric test that is used on one group of people, but the data is taken on two different occasions or under two different conditions. This technique is aimed for the pre-test/post-test study design. The same person is tested on a continuous measure at Time 1 (pre-intervention) and Time 2 (post-intervention) after they have been exposed to some intervention (Pallant, 2010).

This test will indicate whether there is a statistical significance between the mean score of Time 1 and Time 2. When analysing the data, we will look at the probability (p) value. If the p value is less than 0.05, it can be concluded that there is a statistical difference between the two time periods.

3.7.2 Independent t-test

The Independent t-test is a parametric test that is used to compare data between two groups of participants. The mean scores will determine whether there is a statistical significance between the two groups. This tests the probability that the two sets of data came from the same population (Pallant, 2010).

To determine if there is any significance in the data between the two groups, we looked at the probability (p) value. If the p value was less or equal than 0.05, there is a significant difference between the two groups. If the p value is greater than 0.05, there is no statistical significance between the two groups.

3.8 Ethical Considerations

All participants that wished to partake in this study were requested to read the information form (Appendix C) and sign the consent form (Appendix D) specific to this study. The information and consent form outlined the names of the researcher, the purpose of the study and the benefits of partaking in the study, participant assessment and the treatment procedure that was specific to this study. Any risks, benefits and discomforts pertaining to the treatment involved were explained and that the participant's safety was ensured throughout the study.

The information and consent form were also explained, and that the participant's privacy would be protected as only the doctor, patient and clinician would have be in the treatment room and that anonymity was ensured as the participant's information was converted into data and therefore cannot be tracked back to the individual. The form also stated that standard doctor/patient confidentiality would be adhered to all the time when compiling the research dissertation.

The participants were informed that their participation was voluntary and that they were free to withdraw from the study at any stage. If the participant had any further questions, these were answered or explained by the researcher, whose contact details were made available. The participants were then required to sign the information and consent form, signifying that they understood all that was required of them in this study. Results of the study would be made available to them on request.

Participants that received treatment were informed of the procedure; it should not have caused any pain or discomfort as it is a non-invasive treatment.

Participants would have been referred to and if it was necessary.

All the participants that were part of the control group were offered chiropractic treatment after their contribution to the study was complete; this was to comply with any ethics that needed to be considered.

This study was approved by the Research Ethics Committee of the University of Johannesburg, the research ethics number is REC-241112-035 (Appendix I). The research study was also approved by the Higher Degrees Committee at the University of Johannesburg (Appendix J)

This study has also been analysed by the anti-plagiarism software Turnitin which had ensured that there was no plagiarism while compiling this study (Appendix K).

CHAPTER 4 : RESULTS

4.1 Introduction

The objective data for this study was measured by the Zebris FDM Gait Analysis System. Measurements for each participant were taken before and after treatment with biomechanical pelvic blocks.

The objective data was analysed as follows:

- Demographic analysis was used to evaluate the participant distribution within the study.
- Test for normality was performed to using the Kolmogorov-Smirnov test. This test is used when there is a large sample size.

4.2 Demographic Analysis

This study consisted of **100** participants (N=100) which were divided into two groups (Group A and B). Group A had fifty participants which were treated with biomechanical pelvic blocks and Group B had fifty participants which was the control group as they did not receive any treatment.

According to the demographic analysis (Table 4.1), the mean age in this study was **23.99** years old with the median age being **24**. The minimum age was **19** years old and maximum age was **30** years old; the difference in age was **11** years old. In Group A there were **36** females and **14** males. In Group B there were **30** females and **20** males that participated.

Table 4.1: Demographic Data Analysis

Data	Statistics
N	100
Mean age	23.99
Median age	24.00
Minimum age	19
Maximum age	30
Age range	11
Gender Distribution: **Group A**	36 Females 14 Males
Gender Distribution: **Group B**	30 Females 20 Males

4.3 Objective Data

4.3.1 Test for normality

The normality test that was used for this study was the Kolmogorov-Smirnov test as there was a large sample size. If the p-value was more than 0.05 ($p > 0.05$) this indicated that the data was evenly distributed. However, if the p-value was less than or equal to 0.005 ($p \leq 0.05$) the data was not evenly distributed.

The test for normality was used to determine whether parametric or non-parametric tests should be used to analyse the data. If the data was evenly distributed then parametric tests can be used however, if the data was not evenly distributed, non-parametric testing must be used.

4.3.2 Intra-group analysis using parametric testing

a. Foot rotation

Table 4.2: Intra-group analysis - Paired t-test for foot rotation in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left foot rotation	4.89	4.75	0.14	0.74	**No**
Right foot rotation	6.91	7.57	0.65	0.12	**No**

In Group A (Table 4.2), the average for left foot rotation was **4.89 degrees** before treatment and decreased by **0.14 degrees** to **4.75 degrees** after treatment. The paired t-test revealed a p-value of **0.74** ($p > 0.05$) which was not statistically significant between the mean left foot rotation score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.2), the average for right foot rotation was **6.91 degrees** before treatment and increased by **0.65 degrees** to **7.57 degrees** after treatment. The paired t-test revealed a p-value of **0.12** ($p > 0.05$) which was not statistically significant between the mean right foot rotation score before and after treatment with the use of pelvic blocking.

Table 4.3: Intra-group analysis - Paired t-test for foot rotation in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left foot rotation	3.87	4.50	0.63	0.04	**Yes**
Right foot rotation	7.46	8.03	0.57	0.14	**No**

In Group B (Table 4.3), the average for left foot rotation was **3.87 degrees** before intervention and increased by **0.63 degrees** to **4.50 degrees** after intervention. The paired t-test revealed a p-value of **0.04** ($p \leq 0.05$) which was statistically significant between the mean left foot rotation score before and after intervention in the control group.

In Group B (Table 4.3), the average for right foot rotation was **7.46 degrees** before intervention and increased by **0.57 degrees** to **8.03 degrees** after intervention. The paired t-test revealed a p-value of **0.14** ($p > 0.05$) which was not statistically significant between the mean right foot rotation score before and after intervention in the control group.

b. Step time

Table 4.4: Intra-group analysis - Paired t-test for step time in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left step time	0.58	0.57	0.01	0.31	**No**
Right step time	0.58	0.57	0.01	0.26	**No**

In Group A (Table 4.4), the average for left step time was **0.58 seconds** before treatment and decreased by **0.01 seconds** to **0.57 seconds** after treatment. The paired t-test revealed a p-value of **0.31** ($p > 0.05$) which was not statistically significant between the mean left side step time score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.4), the average for right step time was **0.58 seconds** before treatment and decreased by **0.01 seconds** to **0.57 seconds** after treatment. The paired t-test revealed a p-value of **0.26** ($p > 0.05$) which was not statistically significant between the mean right step time score before and after treatment with the use of pelvic blocking.

Table 4.5: Intra-group analysis - Paired t-test for step time in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left step time	0.57	0.57	0.00	0.33	**No**
Right step time	0.56	0.57	0.01	0.35	**No**

In Group B (Table 4.5), the average for left step time was **0.57 seconds** before intervention and remained the same at **0.57 seconds** after intervention. The paired t-test revealed a p-value of **0.33** ($p > 0.05$) which was not statistically significant between the mean left step time score before and after intervention in the control group.

In Group B (Table 4.5), the average for right step time was **0.56 seconds** before intervention and increased by **0.01 seconds** to **0.57 seconds** after intervention. The paired t-test revealed a p-value of **0.35** ($p > 0.05$) which was not statistically significant between the mean right step time score before and after intervention in the control group.

c. Step length

Table 4.6: Intra-group analysis - Paired t-test for step length in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left step length	59.30	58.74	0.56	0.19	**No**
Right step length	59.34	58.68	0.66	0.19	**No**

In Group A (Table 4.6), the average for left side step length was **59.30 cm** before treatment and decreased by **0.56 cm** to **58.74 cm** after treatment. The paired t-test revealed a p-value of **0.19** ($p > 0.05$) which was not statistically significant between the mean left side step length score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.6), the average for right step length was **59.34 cm** before treatment and decreased by **0.66 cm** to **58.68 cm** after treatment. The paired t-test revealed a p-value of **0.19** ($p > 0.05$) which was not statistically significant between the mean right step length score before and after treatment with the use of pelvic blocking.

Table 4.7: Intra-group analysis - Paired t-test for step length in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left step length	59.76	58.92	0.84	0.07	**No**
Right step length	60.82	60.36	0.46	0.32	**No**

In Group B (Table 4.7), the average for left step length was **59.76 cm** before intervention and decreased by **0.84 cm** to **58.92 cm** after intervention. The paired t-test revealed a p-value of **0.07** (p > 0.05) which was not statistically significant between the mean left step length score before and after intervention in the control group.

In Group B (Table 4.7), the average for right step length was **60.82 cm** before intervention and decreased by **0.46 cm** to **60.36 cm** after intervention. The paired t-test revealed a p-value of **0.32** (p > 0.05) which was not statistically significant between the mean right step length score before and after intervention in the control group.

d. Stance phase

Table 4.8: Intra-group analysis - Paired t-test for stance phase in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left stance phase	64.15	63.96	0.19	0.30	**No**
Right stance phase	63.97	63.80	0.17	0.39	**No**

In Group A (Table 4.8), the average for left stance phase was **64.15%** before treatment and decreased by **0.19%** to **63.96%** after treatment. The paired t-test revealed a p-value of **0.30** (p > 0.05) which was not statistically significant between the mean left side stance phase score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.8), the average for right stance phase was **63.97%** before treatment and decreased by **0.17%** to **63.80%** after treatment. The paired t-test revealed a p-value of **0.39** (p > 0.05) which was not statistically significant between the mean right stance phase score before and after treatment with the use of pelvic blocking.

Table 4.9: Intra-group analysis - Paired t-test for stance phase in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left stance phase	63.78	63.80	0.02	0.94	**No**
Right stance phase	64.07	63.56	0.51	0.03	**Yes**

In Group B (Table 4.9), the average for left stance phase was **63.78%** before intervention and increased by **0.02%** to **63.80%** after intervention. The paired t-test revealed a p-value of **0.94** ($p > 0.05$) which was not statistically significant between the mean left stance phase score before and after intervention in the control group.

In Group B (Table 4.9), the average for right stance phase was **64.07%** before intervention and decreased by **0.51%** to **63.56%** after intervention. The paired t-test revealed a p-value of **0.03** ($p \leq 0.05$) which was statistically significant between the mean right stance phase score before and after intervention in the control group.

e. Load response

Table 4.10: Intra-group analysis - Paired t-test for load response in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left load response	13.97	13.77	0.20	0.24	**No**
Right load response	14.09	13.94	0.15	0.36	**No**

In Group A (Table 4.10), the average for left load response was **13.97%** before treatment and decreased by **0.20%** to **13.77%** after treatment. The paired t-test revealed a p-value of **0.24** ($p > 0.05$) which was not statistically significant between the mean left side load response score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.10), the average for right load response was **14.09%** before treatment and decreased by **0.15%** to **13.94%** after treatment. The paired t-test revealed a p-value of **0.36** ($p > 0.05$) which was not statistically significant between the mean right-side load response score before and after treatment with the use of pelvic blocking.

Table 4.11: Intra-group analysis - Paired t-test for load response in Group B

Gait parameter	Pre-treatment	Post treatment	Change	p-value	Statistically significant?
Left load response	13.77	13.55	0.22	0.23	**No**
Right load response	13.94	13.68	0.26	0.27	**No**

In Group B (Table 4.11), the average for left load response was **13.77%** before intervention and decreased by **0.22%** to **13.55%** after intervention. The paired t-test revealed a p-value of **0.23** (p > 0.05) which was not statistically significant between the mean left load response score before and after intervention in the control group.

In Group B (Table 4.11), the average for right load response was **13.94%** before intervention and decreased by **0.26%** to **13.68%** after intervention. The paired t-test revealed a p-value of **0.27** (p > 0.05) which was not statistically significant between the mean right load response score before and after intervention in the control group.

f. Mid stance

Table 4.12: Intra-group analysis - Paired t-test for mid stance in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left mid-stance	35.97	35.97	0.00	0.99	**No**
Right mid-stance	35.80	35.84	0.04	0.82	**No**

In Group A (Table 4.12), the average for left mid stance was **35.97%** before intervention and remained the same at **35.97%** after intervention. The paired t-test revealed a p-value of **0.99** (p > 0.05) which was not statistically significant between the mean left side mid stance score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.12), the average for right mid stance was **35.80%** before treatment and increased by **0.04%** to **35.84%** after treatment. The paired t-test revealed a p-value of **0.82** (p > 0.05) which was not statistically significant between the mean right mid stance score before and after treatment with the use of pelvic blocking.

Table 4.13: Intra-group analysis - Paired t-test for mid stance in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left mid-stance	35.85	36.54	0.69	0.01	**Yes**
Right mid-stance	36.21	36.08	0.13	0.64	**No**

In Group B (Table 4.13), the average for left mid stance was **35.85%** before intervention and increased by **0.69%** to **36.54%** after intervention. The paired t-test revealed a p-value of **0.01** ($p \leq 0.05$) which was statistically significant between the mean left mid stance score before and after intervention in the control group.

In Group B (Table 4.13), the average for right mid stance was **36.21%** before intervention and decreased by **0.13%** to **36.08%** after intervention. The paired t-test revealed a p-value of **0.64** ($p > 0.05$) which was not statistically significant between the mean right mid stance score before and after intervention in the control group.

g. Pre-swing phase

Table 4.14: Intra-group analysis - Paired t-test for pre-swing in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left pre-swing	14.22	14.01	0.21	0.14	**No**
Right pre-swing	13.96	13.68	0.10	0.55	**No**

In Group A (Table 4.14), the average for left pre-swing was **14.22%** before treatment and decreased by **0.21%** to **14.01%** after treatment. The paired t-test revealed a p-value of **0.14** ($p > 0.05$) which was not statistically significant between the mean left side pre-swing score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.14), the average for right pre-swing was **13.96%** before treatment and decreased by **0.10%** to **13.86%** after treatment. The paired t-test revealed a p-value of **0.55** ($p > 0.05$) which was not statistically significant between the mean right-side pre-swing score before and after treatment with the use of pelvic blocking.

Table 4.15: Intra-group analysis - Paired t-test for pre-swing in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left pre-swing	14.09	13.78	0.31	0.18	**No**
Right pre-swing	13.84	13.69	0.15	0.35	**No**

In Group B (Table 4.15), the average for left pre-swing was **14.09%** before intervention and decreased by **0.31%** to **13.78%** after intervention. The paired t-test revealed a p-value of **0.18** ($p > 0.05$) which was not statistically significant between the mean left pre-swing score before and after intervention in the control group.

In Group B (Table 4.15), the average for right pre-swing was **13.84%** before intervention and decreased by **0.15%** to **13.69%** after intervention. The paired t-test revealed a p-value of **0.35** ($p > 0.05$) which was not statistically significant between the mean right pre-swing score before and after intervention in the control group.

h. Swing phase

Table 4.16: Intra-group analysis - Paired t-test for swing phase in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left swing phase	35.84	36.04	0.20	0.30	**No**
Right swing phase	36.03	36.20	0.17	0.39	**No**

In Group A (Table 4.16), the average for left swing phase was **35.84%** before treatment and increased by **0.20%** to **36.04%** after treatment. The paired t-test revealed a p-value of **0.30** ($p > 0.05$) which was not statistically significant between the mean left side swing phase score before and after treatment with the use of pelvic blocking.

In Group A (Table 4.16), the average for right-side swing phase was **36.03%** before treatment and increased by **0.17%** to **36.20%** after treatment. The paired t-test revealed a p-value of **0.39** ($p > 0.05$) which was not statistically significant between the mean right-side swing phase score before and after treatment with the use of pelvic blocking.

Table 4.17: Intra-group analysis - Paired t-test for swing phase in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Left swing phase	36.22	36.20	0.02	0.94	**No**
Right swing phase	35.93	36.46	0.53	0.02	**Yes**

In Group B (Table 4.17), the average for left swing phase was **36.22%** before intervention and decreased by **0.02%** to **36.20%** after intervention. The paired t-test revealed a p-value of **0.94** ($p > 0.05$) which was not statistically significant between the mean left swing phase score before and after intervention in the control group.

In Group B (Table 4.17), the average for right swing phase was **35.93%** before intervention and increased by **0.53%** to **36.46%** after intervention. The paired t-test revealed a p-value of **0.02** ($p \leq 0.05$) which was statistically significant between the mean right swing phase score before and after intervention in the control group.

i. Total double support

Table 4.18: Intra-group analysis - Paired t-test for total double support in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Total double support	25.15	27.91	0.24	0.34	**No**

In Group A (Table 4.18), the average for total double support was **28.15%** before treatment and decreased by **0.24%** to **27.91%** after treatment. The paired t-test revealed a p-value of **0.34** ($p > 0.05$) which was not statistically significant between the mean total double support score before and after treatment with the use of pelvic blocking.

Table 4.19: Intra-group analysis - Paired t-test for total double support in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Total double support	27.88	27.37	0.51	0.15	**No**

In Group B (Table 4.19), the average for total double support was **27.88%** before intervention and decreased by **0.51%** to **27.37%** after intervention. The paired t-test revealed a p-value of **0.15** ($p > 0.05$) which was not statistically significant between the mean total double support score before and after intervention in the control group.

j. Step width

Table 4.20: Intra-group analysis - Paired t-test for step width in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Step width	10.04	10.44	0.40	0.14	**No**

In Group A (Table 4.20), the average for step width was **10.04 cm** before treatment and increased by **0.40 cm** to **10.44 cm** after treatment. The paired t-test revealed a p-value of **0.14** (p > 0.05) which was not statistically significant between the mean step width score before and after treatment with the use of pelvic blocking.

Table 4.21: Intra-group analysis - Paired t-test for step width in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Step width	10.96	11.39	0.43	0.08	**No**

In Group B (Table 4.21), the average for step width was **10.96 cm** before intervention and increased by **0.43 cm** to **11.39 cm** after intervention. The paired t-test revealed a p-value of **0.08** (p > 0.05) which was not statistically significant between the mean step width score before and after intervention in the control group.

k. Stride length

Table 4.22: Intra-group analysis - Paired t-test for stride length in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Stride length	118.64	117.32	1.32	0.13	**No**

In Group A (Table 4.22), the average for stride length was **118.64 cm** before treatment and decreased by **1.32 cm** to **117.32 cm** after treatment. The paired t-test revealed a p-value of **0.13** (p > 0.05) which was not statistically significant between the mean stride length score before and after treatment with the use of pelvic blocking.

Table 4.23: Intra-group analysis - Paired t-test for stride length in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Stride length	120.56	119.22	1.34	0.10	**No**

In Group B (Table 4.23), the average for stride length was **120.56 cm** before intervention and decreased by **1.34 cm** to **119.22 cm** after intervention. The paired t-test revealed a p-value of **0.10** ($p > 0.05$) which was not statistically significant between the mean stride length score before and after intervention in the control group.

l. Stride time

Table 4.24: Intra-group analysis - Paired t-test for stride time in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Stride time	1.16	1.15	0.01	0.29	**No**

In Group A (Table 4.24), the average for stride time was **1.16 seconds** before treatment and decreased by **0.01 seconds** to **1.15 seconds** after treatment. The paired t-test revealed a p-value of **0.29** ($p > 0.05$) which was not statistically significant between the mean stride time score before and after treatment with the use of pelvic blocking.

Table 4.25: Intra-group analysis - Paired t-test for stride time in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Stride time	1.13	1.13	0.00	0.91	**No**

In Group B (Table 4.25), the average for stride time was **1.13 seconds** before intervention and remained the same at **1.13 seconds** after intervention. The paired t-test revealed a p-value of **0.91** ($p > 0.05$) which was not statistically significant between the mean stride time score before and after intervention in the control group.

m. Cadence

Table 4.26: Intra-group analysis - Paired t-test for cadence in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Cadence	104.58	105.38	0.80	0.30	**No**

In Group A (Table 4.26), the average for cadence was **104.58 steps/min** before treatment and increased by **0.80 steps/min** to **105.38 steps/min** after treatment. The paired t-test revealed a p-value of **0.30** ($p > 0.05$) which was not statistically significant between the mean cadence score before and after treatment with the use of pelvic blocking.

Table 4.27: Intra-group analysis - Paired t-test for cadence in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Cadence	106.48	106.62	0.14	0.84	**No**

In Group B (Table 4.27), the average for cadence was **106.48 steps/min** before intervention and increased by **0.14 steps/min** to **106.62 steps/min** after intervention. The paired t-test revealed a p-value of **0.84** ($p > 0.05$) which was not statistically significant between the mean cadence score before and after intervention in the control group.

n. Velocity

Table 4.28: Intra-group analysis - Paired t-test for velocity in Group A

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Velocity	3.72	3.72	0.00	1.00	**No**

In Group A (Table 4.28), the average for velocity was **3.72 km/h** before treatment and remained the same after treatment with a value of **3.72 km/h** as the mean difference was **0.00 km/h**. The paired t-test revealed a p-value of **1.00** ($p > 0.05$) which was not statistically significant between the mean velocity score before and after treatment with the use of pelvic blocking.

Table 4.29: Intra-group analysis - Paired t-test for velocity in Group B

Gait parameter	Pre-treatment mean	Post treatment mean	Change	p-value	Statistically significant?
Velocity	3.85	3.81	0.04	0.40	**No**

In Group B (Table 4.29), the average for velocity was **3.85 km/h** before intervention and decreased by **0.04 km/h** to **3.81 km/h** after intervention. The paired t-test revealed a p-value of **0.40** ($p > 0.05$) which was not statistically significant between the mean velocity score before and after intervention in the control group.

4.3.3 Inter-group analysis using parametric testing

a. Foot rotation

Table 4.30: Inter-group analysis - Independent t-test for foot rotation

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left foot rotation	Pre-treatment	A	4.89	4.88	0.29	**No**
		B	3.87	4.72		
	Post treatment	A	4.75	5.50	0.81	**No**
		B	4.50	4.94		
Right foot rotation	Pre-treatment	A	6.91	5.00	0.61	**No**
		B	7.46	5.48		
	Post treatment	A	7.57	5.03	0.66	**No**
		B	8.03	5.38		

An independent-samples t-test was conducted to compare the pre-treatment for left foot rotation scores for Group A and Group B (Table 4.30). There was no significant difference in scores for Group A (M = **4.89 degrees**, SD = **5.50**) and Group B (M = **3.87 degrees**, SD = **4.72**), p-value = **0.29** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for left foot rotation scores for Group A and Group B (Table 4.30). There was no significant difference in scores for Group A (M = **4.75 degrees**, SD = **4.75**) and Group B (M = **4.50 degrees**, SD =**4.94**), p-value = **0.81** (p > 0.05).

An independent-samples t-test was conducted to compare the pre-treatment for right foot rotation scores for Group A and Group B (Table 4.30). There was no significant difference in scores for Group A (M = **6.91 degrees**, SD = **5.00**) and Group B (M = **7.46 degrees**, SD = **5.48**), p-value = **0.61** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for right foot rotation scores for Group A and Group B (Table 4.30). There was no significant difference in scores for Group A (M = **7.57 degrees**, SD = **5.03**) and Group B (M = **8.03 degrees**, SD = **5.38**), p-value = **0.66** ($p > 0.05$).

b. Step time

Table 4.31: Inter-group analysis - Independent t-test for step time

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left Step time	Pre-treatment	A	0.58	0.05	0.35	**No**
		B	0.57	0.05		
	Post treatment	A	0.57	0.06	0.37	**No**
		B	0.57	0.04		
Right Step time	Pre-treatment	A	0.58	0.06	0.12	**No**
		B	0.56	0.04		
	Post treatment	A	0.57	0.06	0.52	**No**
		B	0.57	0.04		

An independent-samples t-test was conducted to compare the pre-treatment for left step time scores for Group A and Group B (Table 4.31). There was no significant difference in scores for Group A (M = **0.58 seconds**, SD = **0.05**) and Group B (M = **0.57 seconds**, SD = **0.05**), p-value = **0.35** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for left step time scores for Group A and Group B (Table 4.31). There was no significant difference in scores for Group A (M = **0.57 seconds**, SD = **0.06**) and Group B (M = **0.57 seconds**, SD = **0.04**), p-value = **0.37** ($p > 0.05$).

An independent-samples t-test was conducted to compare the pre-treatment for right step time scores for Group A and Group B (Table 4.31). There was no significant difference in scores for Group A (M = **0.58 seconds**, SD = **0.06**) and Group B (M = **0.56 seconds**, SD = **0.04**), p-value = **0.12** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for right step time scores for Group A and Group B (Table 4.31). There was no significant difference in scores for Group A (M = **0.57 seconds**, SD = **0.06**) and Group B (M = **0.57 seconds**, SD = **0.04**), p-value = **0.52** ($p > 0.05$).

c. Step length

Table 4.32: Inter-group analysis - Independent t-test for step length

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left Step length	Pre-treatment	A	59.30	6.96	0.72	**No**
		B	59.76	6.02		
	Post treatment	A	58.74	6.56	0.89	**No**
		B	58.92	6.08		
Right Step length	Pre-treatment	A	59.34	6.77	0.26	**No**
		B	60.82	6.13		
	Post treatment	A	58.68	6.28	0.19	**No**
		B	60.36	6.35		

An independent-samples t-test was conducted to compare the pre-treatment for left step length scores for Group A and Group B (Table 4.32). There was no significant difference in scores for Group A (M = **59.30 cm**, SD = **6.96**) and Group B (M = **59.76 cm**, SD = **6.02**), p-value = **0.72** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for left step length scores for Group A and Group B (Table 4.32). There was no significant difference in scores for Group A (M = **58.74 cm**, SD = **6.56**) and Group B (M = **58.92 cm**, SD = **6.08**), p-value = **0.89** ($p > 0.05$).

An independent-samples t-test was conducted to compare the pre-treatment for right step length scores for Group A and Group B (Table 4.32). There was no significant difference in scores for Group A (M = **59.34 cm**, SD = **6.77**) and Group B (M = **60.82 cm**, SD = **6.13**), p-value = **0.26** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for right step length scores for Group A and Group B (Table 4.32). There was no significant difference in scores for Group A (M = **58.68 cm**, SD = **6.28**) and Group B (M = **60.36 cm**, SD = **6.35**), p-value = **0.19** ($p > 0.05$).

d. Stance phase

Table 4.33: Inter-group analysis - Independent t-test for stance phase

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left stance phase	Pre-treatment	A	64.15	1.77	0.31	**No**
		B	63.78	1.90		
	Post treatment	A	63.96	1.39	0.65	**No**
		B	63.80	2.01		
Right stance phase	Pre-treatment	A	63.97	1.74	0.78	**No**
		B	64.07	1.96		
	Post treatment	A	63.80	1.75	0.51	**No**
		B	63.56	1.76		

An independent-samples t-test was conducted to compare the pre-treatment for left stance phase scores for Group A and Group B (Table 4.33). There was no significant difference in scores for Group A (M = **64.15%,** SD = **1.77**) and Group B (M = **63.78%**, SD = **1.90**), p-value = **0.31** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for left stance phase scores for Group A and Group B (Table 4.33). There was no significant difference in scores for Group A (M = **63.96%**, SD = **1.39**) and Group B (M = **63.80%**, SD = **2.01**), p-value = **0.65** (p > 0.05).

An independent-samples t-test was conducted to compare the pre-treatment for right stance phase scores for Group A and Group B (Table 4.33). There was no significant difference in scores for Group A (M = **63.97%**, SD = **1.74**) and Group B (M = **64.07%**, SD = **1.96**), p-value = **0.78** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for right stance phase scores for Group A and Group B (Table 4.33). There was no significant difference in scores for Group A (M = **63.80 %**, SD = **1.75**) and Group B (M = **63.56%**, SD = **1.76**), p-value = **0.51** (p > 0.05).

e. Load response

Table 4.34: Inter-group analysis - Independent t-test for load response

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left load response	Pre-treatment	A	13.97	1.59	0.53	**No**
		B	13.777	1.62		
	Post treatment	A	13.77	1.48	0.52	**No**
		B	13.55	1.95		
Right load response	Pre-treatment	A	14.09	1.71	0.70	**No**
		B	13.95	1.93		
	Post treatment	A	13.94	1.33	0.40	**No**
		B	13.69	1.70		

An independent-samples t-test was conducted to compare the pre-treatment for left load response scores for Group A and Group B (Table 4.34). There was no significant difference in scores for Group A (M = **13.97%**, SD = **1.59**) and Group B (M = **13.77%**, SD = **1.62**), p-value = **0.53** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for left load response scores for Group A and Group B (Table 4.34). There was no significant difference in scores for Group A (M = **13.77%**, SD = **1.48**) and Group B (M = **13.55%**, SD = **1.95**), p-value = **0.52** ($p > 0.05$).

An independent-samples t-test was conducted to compare the pre-treatment for right load response scores for Group A and Group B (Table 4.34). There was no significant difference in scores for Group A (M = **14.09%**, SD = **1.71**) and Group B (M = **13.95%**, SD = **1.93**), p-value = **0.70** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for right load response scores for Group A and Group B (Table 4.34). There was no significant difference in scores for Group A (M = **13.94%**, SD = **1.33**) and Group B (M = **13.69%**, SD = **1.70**), p-value = **0.40** (p > 0.05).

f. Mid stance phase

Table 4.35: Inter-group analysis - Independent t-test for mid stance phase

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left mid stance phase	Pre-treatment	A	35.97	1.68	0.73	**No**
		B	35.85	1.83		
	Post treatment	A	35.97	1.65	0.12	**No**
		B	36.54	1.91		
Right mid stance phase	Pre-treatment	A	35.80	1.68	0.26	**No**
		B	36.21	1.96		
	Post treatment	A	35.84	1.35	0.49	**No**
		B	36.08	2.05		

An independent-samples t-test was conducted to compare the pre-treatment for left mid stance phase scores for Group A and Group B (Table 4.35). There was no significant difference in scores for Group A (M = **35.97%**, SD = **1.68**) and Group B (M = **35.85%**, SD = **1.83**), p-value = **0.73** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for left mid stance phase scores for Group A and Group B (Table 4.35). There was no significant difference in scores for Group A (M = **35.97%,** SD = **1.65**) and Group B (M = **36.54%**, SD = **1.91**), p-value = **0.12** (p > 0.05).

An independent-samples t-test was conducted to compare the pre-treatment for right mid stance phase scores for Group A and Group B (Table 4.35). There was no significant difference in scores for Group A (M = **35.80%**, SD = **1.68**) and Group B (M = **36.21%**, SD = **1.96**), p-value = **0.26** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for right mid stance phase scores for Group A and Group B (Table 4.35). There was no significant difference in scores for Group A (M = **35.84%**, SD = **1.35**) and Group B (M = **36.08%**, SD = **2.05**), p-value = **0.49** (p > 0.05).

g. Pre-swing phase

Table 4.36: Inter-group analysis - Independent t-test for pre-swing phase

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left pre-swing phase	Pre-treatment	A	14.22	1.59	0.70	**No**
		B	14.09	1.89		
	Post treatment	A	14.01	1.29	0.43	**No**
		B	13.78	1.63		
Right pre-swing phase	Pre-treatment	A	13.96	1.58	0.72	**No**
		B	13.84	1.64		
	Post treatment	A	13.86	1.49	0.62	**No**
		B	13.69	1.85		

An independent-samples t-test was conducted to compare the pre-treatment for left pre-swing phase scores for Group A and Group B (Table 4.36). There was no significant difference in scores for Group A (M = **14.22%**, SD = **1.59**) and Group B (M = **14.09%,** SD = **1.89**), p-value = **0.70** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for left pre-swing phase scores for Group A and Group B (Table 4.36). There was no significant difference in scores for Group A (M = **14.01%**, SD = **1.29**) and Group B (M = **13.78%**, SD = **1.63**), p-value = **0.43** ($p > 0.05$).

An independent-samples t-test was conducted to compare the pre-treatment for right pre-swing phase scores for Group A and Group B (Table 4.36). There was no significant difference in scores for Group A (M = **13.96%**, SD = **1.58**) and Group B (M = **13.84%**, SD = **1.64**), p-value = **0.72** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for right pre-swing phase scores for Group A and Group B (Table 4.36). There was no significant difference in scores for Group A (M = **13.86%**, SD = **1.49**) and Group B (M = **13.69%**, SD = **1.85**), p-value = **0.62** ($p > 0.05$).

h. Swing phase

Table 4.37: Inter-group analysis - Independent t-test for swing phase

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Left swing phase	Pre-treatment	A	35.85	1.77	0.31	**No**
		B	36.22	1.90		
	Post treatment	A	36.04	1.39	0.65	**No**
		B	36.20	2.01		
Right swing phase	Pre-treatment	A	36.03	1.74	0.78	**No**
		B	35.93	1.96		
	Post treatment	A	36.20	1.75	0.47	**No**
		B	36.46	1.75		

An independent-samples t-test was conducted to compare the pre-treatment for left swing phase scores for Group A and Group B (Table 4.37). There was no significant difference in scores for Group A (M = **35.85%**, SD = **1.77**) and Group B (M = **36.22%**, SD = **1.90**), p-value = **0.31** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for left swing phase scores for Group A and Group B (Table 4.37). There was no significant difference in scores for Group A (M = **36.04%**, SD = **1.39**) and Group B (M = **36.20%**, SD = **2.01**), p-value = **0.65** ($p > 0.05$).

An independent-samples t-test was conducted to compare the pre-treatment for right swing phase scores for Group A and Group B (Table 4.37). There was no significant difference in scores for Group A (M = **36.03%**, SD = **1.74**) and Group B (M = **35.93%**, SD = **1.96**), p-value = **0.78** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for right swing phase scores for Group A and Group B (Table 4.37). There was no significant difference in scores for Group A (M = **36.20%**, SD = **1.75**) and Group B (M = **36.46%**, SD = **1.75**), p-value = **0.47** ($p > 0.05$).

i. Total double support

Table 4.38: Inter-group analysis - Independent t-test for total double support

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Total double support	Pre-treatment	A	28.15	2.97	0.67	**No**
		B	27.88	3.23		
	Post treatment	A	27.91	2.55	0.36	**No**
		B	27.37	3.24		

An independent-samples t-test was conducted to compare the pre-treatment for total double support scores for Group A and Group B (Table 4.38). There was no significant difference in scores for Group A (M = **28.15%**, SD = **2.97**) and Group B (M = **27.88%**, SD = **3.23**), p-value = **0.67** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for total double support scores for Group A and Group B (Table 4.38). There was no significant difference in scores for Group A (M = **27.91%**, SD = **2.55**) and Group B (M = **27.37%**, SD = **3.24**), p-value = **0.36** (p > 0.05).

j. Step width

Table 4.39: Inter-group analysis - Independent t-test for step width

Gait Parameter	**Pre/Post treatment**	**Group**	**Mean**	**Std. deviation**	**p-value**	**Statistically significant?**
Step width	Pre-treatment	A	10.04	3.24	0.15	**No**
		B	10.96	3.10		
	Post treatment	A	10.44	3.00	0.11	**No**
		B	11.39	2.78		

An independent-samples t-test was conducted to compare the pre-treatment for step width scores for Group A and Group B (Table 4.39). There was no significant difference in scores for Group A (M = **10.04 cm**, SD = **3.24**) and Group B (M = **10.96 cm**, SD = **3.10**), p-value = **0.15** (p > 0.05).

An independent-samples t-test was conducted to compare the post treatment for step width scores for Group A and Group B (Table 4.39). There was no significant difference in scores for Group A (M = **10.44 cm**, SD = **3.00**) and Group B (M = **11.39 cm**, SD = **2.79**), p-value = **0.11** (p > 0.05).

k. Stride length

Table 4.40: Inter-group analysis - Independent t-test for stride length

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Stride length	Pre-treatment	A	118.64	13.53	0.45	**No**
		B	120.56	11.85		
	Post treatment	A	117.32	12.52	0.44	**No**
		B	119.22	12.12		

An independent-samples t-test was conducted to compare the pre-treatment for stride length scores for Group A and Group B (Table 4.40). There was no significant difference in scores for Group A (M = **118.64 cm**, SD = **13.53**) and Group B (M = **120.56 cm**, SD = **11.85**), p-value = **0.45** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for stride length scores for Group A and Group B (Table 4.40). There was no significant difference in scores for Group A (M = **117.32 cm**, SD = **12.52**) and Group B (M = **119.22 cm**, SD = **12.12**), p-value = **0.44** ($p > 0.05$).

l. Stride time

Table 4.41: Inter-group analysis - Independent t-test for stride time

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Stride time	Pre-treatment	A	1.16	0.11	0.21	**No**
		B	1.13	0.08		
	Post treatment	A	1.15	0.11	0.43	**No**
		B	1.13	0.08		

An independent-samples t-test was conducted to compare the pre-treatment for stride time scores for Group A and Group B (Table 4.41). There was no significant difference in scores for Group A (M = **1.16 seconds**, SD = **0.11**) and Group B (M = **1.13 seconds**, SD = **0.08**), p-value = **0.21** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for stride time scores for Group A and Group B (Table 4.41). There was no significant difference in scores for Group A (M = **1.15 seconds**, SD = **0.11**) and Group B (M = **1.13 seconds**, SD = **0.08**), p-value = **0.43** ($p > 0.05$).

m. Cadence

Table 4.42: Inter-group analysis - Independent t-test for cadence

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Cadence	Pre-treatment	A	104.58	9.52	0.28	**No**
		B	106.48	7.71		
	Post treatment	A	105.38	10.11	0.48	**No**
		B	106.62	7.33		

An independent-samples t-test was conducted to compare the pre-treatment for cadence scores for Group A and Group B (Table 4.42). There was no significant difference in scores for Group A (M = **104.58 steps/min**, SD = **9.52**) and Group B (M = **106.48 steps/min**, SD = **7.71**), p-value = **0.28** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for cadence scores for Group A and Group B (Table 4.42). There was no significant difference in scores for Group A (M = **105.38 steps/min**, SD = **10.11**) and Group B (M = **106.62 steps/min**, SD = **7.33**), p-value = **0.48** ($p > 0.05$).

n. Velocity

Table 4.43: Inter-group analysis - Independent t-test for velocity

Gait Parameter	Pre/Post treatment	Group	Mean	Std. deviation	p-value	Statistically significant?
Velocity	Pre-treatment	A	3.72	0.59	0.27	**No**
		B	3.85	0.53		
	Post treatment	A	3.72	0.56	0.41	**No**
		B	3.81	0.50		

An independent-samples t-test was conducted to compare the pre-treatment for velocity scores for Group A and Group B (Table 4.43). There was no significant difference in scores for Group A (M = **3.72 km/h**, SD = **0.59**) and Group B (M = **3.85 km/h**, SD = **0.53**), p-value = **0.27** ($p > 0.05$).

An independent-samples t-test was conducted to compare the post treatment for velocity scores for Group A and Group B (Table 4.43). There was no significant difference in scores for Group A (M = **3.72 km/h**, SD = **0.56**) and Group B (M = **3.81 km/h**, SD = **0.50**), p-value = **0.41** ($p > 0.05$).

CHAPTER 5 : DISCUSSION

5.1 Introduction

The aim of this study was to determine whether biomechanical pelvic blocking had an immediate effect on the gait parameters. The gait parameters include foot rotation, step time, step length, step width, stance phase, swing phase, stride length, stride time, total double support, cadence and velocity.

In this chapter, the results obtained in chapter four will be discussed with theories and concepts seen in chapter two.

5.2 Demographic Analysis

This study consisted of **100** participants which were divided into two groups. The minimum age was **19** years old and the maximum age was **30** years old resulting in an age range of **11** years old.

There was a total of **66** females in this study with **36** females in Group A and 30 females in Group B. There was a total of **34** males in this study with **14** males in Group A and **20** males in Group B.

In the inclusion criteria for this study, participants had to be between the age of **18-30** years old to partake in the study. The study conducted by Duffel, Jordan, Cobb & McGregor (2017), revealed that older participants started to show arthritic changes in the hip and knee joints which affected their gait parameter measurements.

5.3 Objective Data

5.3.1 Foot rotation

The left foot rotation for Group A which had decreased by **0.14 degrees** (from **4.89 degrees** pre-treatment to **4.75 degrees** post treatment). In comparison, the left foot rotation in Group B had increased from **3.87 degrees** pre-treatment to **4.50 degrees** post treatment (**0.63 degrees** difference).

The paired t-test for left foot rotation in Group B yielded a p-value of **0.04** but it was later proven to be false by the independent t-test conducted for the inter-group analysis which indicated no statistical significance between the two groups.

There was no statistical significance found with the right foot rotation in both Group A and Group B. In Group A there was an increase of **0.65 degrees** (**6.91 degrees** pre-treatment to **7.57 degrees** post treatment). In Group B, had an increase of **0.57 degrees**, from **7.46 degrees** pre-treatment to **8.03 degrees** post treatment.

Right foot rotation had showed an increase in both groups; moving from internal rotation to external rotation of the foot. The average foot rotation is approximately **7 degrees** (Guthrie, 2015). Group B showed a consistent increase, but the right side increased over the normal value. Group A revealed an increase on the right side, putting the foot into further external rotation, however the left side moved into further internal rotation.

There are numerous factors that could influence the significance in the increase of the right foot rotation for Group B however between the inter-group analysis there was no significance found. This can be due to the uneven distribution of male and female participants between the groups. There was a slight improvement in the rotation of the foot but nothing substantial to prove its effect.

5.3.2 Step time

The left step time for Group A which had decreased by **0.01 seconds** (from **0.58 seconds** pre-treatment to **0.57 seconds** post treatment). In comparison, the left step time in Group B had remained the same at **0.57 seconds**, pre and post treatment.

In Group A, right step time had decreased by **0.01 seconds** (**0.58 seconds** pre-treatment to **0.57 seconds** post treatment). In comparison, Group B right step time had increased, from **0.56 seconds** pre-treatment, by **0.01 seconds** resulting to **0.57 seconds** post-treatment.

There was no statistical significance found within the groups and between the two groups. The average step time is **0.75 seconds** according to Singleton, Keating, McDowell, Coolen & Wall, (1992). These results showed a decrease and all the values normalised to **0.57 seconds** which is less than the normal **0.75 seconds**. We can therefore conclude that pelvic blocking has no effect on the step time in the gait parameters.

5.3.3 Step length

The left step length for Group A which had decreased by **0.56 cm** (from **59.30 cm** pre-treatment to **58.74 cm** post treatment). In comparison, the left step length in Group B had decreased from **59.76 cm** pre-treatment to **58.92 cm** post treatment (**0.84 cm** difference).

In Group A, right step length had decreased by **0.66 cm** (**59.34 cm** pre-treatment to **58.68 cm** post treatment). In comparison, Group B right step length had decreased, from **60.82 cm** pre-treatment, by **0.46 cm** resulting to **60.36 cm** post-treatment.

There was no statistical significance found within the intra and inter group analysis. However, there was a consistent decrease between left and right step length, between the two groups. The average step length is **65 cm** (Barker, Craik, Freedman, Herrmann & Hillstrom, 2006) in which both groups produced a lesser value post treatment, compared to their initial measurements.

5.3.4 Stance phase

The left stance phase for Group A which had decreased by **0.19%** (from **64.15%** pre-treatment to **63.96%** post treatment). In comparison, the left stance phase in Group B increased by **0.02%,** from **63.78%** pre-treatment to **63.80%** post treatment.

In Group A, right stance phase had decreased by **0.17%** (**63.97%** pre-treatment to **63.80%** post treatment). Group B right stance phase had also decreased, from **64.07%** pre-treatment, by **0.51%** resulting to **63.56%** post-treatment.

Right stance phase in Group B revealed a statistical significance as the p-value was **0.32**. This was proven false as the inter-group test showed no significance between Group A and Group B.

However, this was favourable as stance phase is 60% of the gait cycle (Samuels, 2018). The statistics don't show any significant data as this is within the normal range of the stance phase.

This can be explained by the decrease in pelvic torsion and the aimed correction of the functional leg length inequality. The stance phase had decrease as the kinematic chain did not have to compensate as much for the change in biomechanics at the pelvis.

5.3.5 Load response

The left load response for Group A which had decreased by **0.20%** (from **13.97%** pre-treatment to **13.77%** post treatment). The left load response in Group B decreased in comparison by **0.22%,** from **13.77%** pre-treatment to **13.55%** post treatment.

In Group A, right load response had decreased by **0.15%** (**14.09%** pre-treatment to **13.94%** post treatment). Group B right load response had also decreased, from **13.94%** pre-treatment, by **0.26%** resulting to **13.68%** post-treatment.

There was no statistical data for load response in both the intra and inter group analysis. There was an improvement on the load response whilst comparing the pre and post treatment values. Group A and Group B both revealed a decrease towards the average load response of **10-12%** (Levine, Richards & Whittle, 2012).

With no improvement of the stance phase discussed in the previous section, it can be determined that all the subdivisions within this phase will show similar results. This could be due to the change in the sacroiliac joint that occurred during the treatment which could have demonstrated minor improvements to the joint motion, but it was within the normal range.

5.3.6 Mid stance phase

The left mid stance phase for Group A which had remained the same from **35.97%** pre-treatment to **35.97%** post treatment. The left mid stance phase in Group B increased in comparison by **0.69%,** from **35.85%** pre-treatment to **36.54%** post treatment.

In Group A, right mid stance phase had increased by **0.04%** (**35.80%** pre-treatment to **35.84%** post treatment). Group B right mid stance phase had decreased, from **36.21%** pre-treatment, by **0.13%** resulting to **36.08%** post-treatment.

The left mid stance phase of Group B revealed a statistical significance with a p-value of **0.01**. This was then proven false by the inter-group analysis as there was no significance between the two groups.

The left mid stance phase in Group B revealed a statistical significance with a p-value of **0.01**. This was later proved to be false as the inter-group analysis was not statistically significant.

However, there was a slight increase in Group A which was towards the normal mid stance phase value of **36%**, according to Debi, Mor, Segal, Segal, Agar, Debbi, Halperin, Haim & Elbaz (2011). Whilst left mid stance in Group B also revealed an increase and right mid stance revealed a decrease, they both were within the normal range of **36%** of the mid stance phase.

This would then correlate with the values of the stance phase discussed previously as well as the load response.

5.3.7 Pre-swing phase

The left pre-swing phase for Group A which had decreased by **0.21%** (from **14.22%** pre-treatment to **14.01%** post treatment). The left pre-swing phase in Group B decreased in comparison by **0.31%,** from **14.09%** pre-treatment to **13.78%** post treatment.

In Group A, right pre-swing phase had decreased by **0.10%** (**13.96%** pre-treatment to **13.86%** post treatment). Group B right mid pre-swing phase had also decreased, from **13.84%** pre-treatment, by **0.15%** resulting to **13.69%** post-treatment.

The average percentage for the pre-swing phase is **15%** (Chan and Rudins, 1994). There was a consistent decrease between the left and right pre-swing phase between the two groups. This was not favourable as the pre-treatment and post measurements were within the normal value ranges. There was no statistical data to prove any immediate effect of the gait parameters.

5.3.8 Swing phase

The left swing phase for Group A which had increased by **0.20%** (from **35.84%** pre-treatment to **35.04%** post treatment). The left swing phase in Group B decreased in comparison by **0.02%,** from **36.22%** pre-treatment to **36.20%** post treatment.

In Group A, right swing phase had increased by **0.17%** (**36.03%** pre-treatment to **36.20%** post treatment). Group B right swing phase had also increased, from **35.93%** pre-treatment, by **0.53%** resulting to **36.46%** post-treatment.

The swing phase is composed of **40%** of the gait cycle (Levine, Richards & Whittle, 2012). The only statistical significance found was in the right stance phase of Group B which had a p-value of **0.02**. There was in increase towards the normal in Group A but left stance phase in Group B revealed a decrease.

5.3.9 Total double support

The total double support for Group A which had decreased by **0.24%** (from **28.15%** pre-treatment to **27.91%** post treatment). The total double support in Group B decreased as well by **0.51%,** from **27.88%** pre-treatment to **27.37%** post treatment.

According to Levine, Richards & Whittle (2012), the normal total double support is **20%** on average. Even though there was no statistical significance found between the groups there was a favourable decrease of the measurements towards the normal.

As discussed previously, there was an improvement with the stance and swing phase which would have a direct effect on the total double support; this is when both feet are in contact with the ground during the gait cycle.

5.3.10 Step width

The step width for Group A which had increased by **0.40 cm** (from **10.04 cm** pre-treatment to **10.44 cm** post treatment). The step width in Group B increased as well by **0.43 cm,** from **10.96 cm** pre-treatment to **11.39 cm** post treatment.

According to Hollman, McDade & Petersen (2011), the mean step width for males was **10.0 cm** while women had the mean step width of **7.9 cm**. This was then averaged to **8.95 cm** for the step width.

There was no statistical significance found within the data but by deductive comparison, the measurements did not reveal favourable values. There was an increase in both groups between the two treatment times and comparing the two groups. The post treatment results were greater than the average **8.95 cm** which then showed the step width was too wide compared to the normal average.

5.3.11 Stride length

The stride length for Group A which had decreased by **1.32 cm** (from **118.64 cm** pre-treatment to **117.32 cm** post treatment). The stride length in Group B decreased as well by **1.34 cm,** from **120.56 cm** pre-treatment to **119.22cm** post treatment.

Between the two groups, there was no statistical significance found. Both Group A and Group B had decreased in the stride length towards the average value of **115 cm** (Tong & Granat, 1999). This then reveals that pelvic blocking had a minor effect on the stride length in the gait parameters but still within the normal range values.

5.3.12 Stride time

The stride time for Group A which had decreased by **0.01 seconds** (from **1.16 seconds** pre-treatment to **1.15 seconds** post treatment). The stride time in Group B remained the same at **1.13 seconds**, pre and post treatment.

The average stride time is approximately **1.07 seconds** (Guthrie, 2015). There was no statistical significance between the two groups or between the two treatment periods. However, Group A did reveal a favourable decrease towards the estimated normal. This then shows that Group A did have a minor effect on the stride time compared to Group B.

5.3.13 Cadence

The cadence for Group A which had increased by **0.80 steps per minute** (from **104.58 steps per minutes** pre-treatment to **105.38 steps per minute** post treatment). The cadence in Group B increased as well by **0.14 steps per minute,** from **106.48 steps per minute** pre-treatment to **106.62 steps per minute** post treatment.

A consistent increase was revealed between the two groups, which moved towards the normal average of **113 steps per minute**. Group A, however showed a greater improvement compared to Group B.

As discussed previously, the step length revealed a decrease in its values which would then show that cadence would increase. This is reliable as step length is inversely proportional to cadence (Samson, Crowe, de Vreede, Dessens, Duursma & Verhaar, 2001).

5.3.14 Velocity

The velocity for Group A which had remained the same at **3.72 km/h**, pre and post treatment. The velocity in Group B decreased in comparison by **0.04 km/h,** from **3.85 km/h** pre-treatment to **3.81 km/h** post treatment.

There was no statistical significance revealed in the data analysis between the two groups. According to Chan and Rudins (1994), the average velocity is between **3.6 – 4.5 km/h**. The results produced in this study was within the normal range with Group B showing a slight decrease. This then reveals that biomechanical pelvic blocking does not influence velocity during the gait cycle.

5.4 In Conclusion

With the discussion above, analysing the data within each group and between the two groups, it was revealed that there was no statistical data to prove that biomechanical pelvic blocking had an immediate effect on gait.

There were minor changes to step length, stance phase, load response phase, midstance phase, swing phase, total double support phase, stride length, stride time and cadence. However, none of these values showed any improvements to the gait parameters

With research previously done, there has been a significant increase with the treatment of biomechanical pelvic blocking comparing it with other treatment methods. These studies were conducted over an extended period which then indicated that biomechanical pelvic blocking is more effective over multiple treatments in comparison to one treatment. This reinforces that patients are required to attend more than one treatment to achieve the required results with regards to sacroiliac joint dysfunction.

Chiropractic manipulation is the most effective treatment for sacroiliac dysfunction. Contra-indications for spinal manipulation include tumours, fractures, aneurysms, clotting disorders and severe sprains which could cause complications if the manipulation is administered to the area (Bergmann & Peterson, 2010). Biomechanical pelvic blocking can be used as an alternative method in treating sacroiliac dysfunction but not as effect in comparison to chiropractic manipulation (Schooling et al, 2004).

In a study conducted by Harradine, Bevan & Carter (2006), it revealed that podiatrists use three different theories to treat any gait dysfunction. They achieve this by looking at the subtalar joint neutral position, the movement in the sagittal plane of the joint and the stress of the tissue in the foot that could alter the biomechanics. Orthotics that are specially made for the patient's foot is their main form of treatment which can then help influence the gait patterns.

By using a multidisciplinary approach to treating sacroiliac dysfunction and any gait abnormalities, patients will have a better prognosis and help them improve their function and movement.

CHAPTER 6 : CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The aim of this study was to determine whether biomechanical pelvic blocking has an immediate effect on the spatiotemporal parameters of gait which was analysed using the Zebris FDM gait analysis system.

Podiatrists use gait analysis to determine if there are any abnormalities in the gait parameters and prescribe the correct treatment protocol for the given condition.

The results in this study showed no changes in the spatiotemporal parameters of gait which suggested that biomechanical pelvic blocking does not influence the sacroiliac joint immediately. Minor changes were found in in step length, stance phase, load response phase, midstance phase, swing phase, total double support phase, stride length, stride time and cadence however they were still within the normal range. Most of the changes found in the gait parameters were statistically insignificant.

This study shows that biomechanical pelvic blocking does not have an immediate effect on gait, but it would be recommended to use multiple treatments to get the benefits of this technique. Previous studies conducted have shown that multiple treatments using biomechanical pelvic blocking does have a positive effect on sacroiliac dysfunction.

This technique can still be used as an alternative for patients who are contra-indicated to chiropractic manipulation to treat sacroiliac dysfunction or a leg length inequality.

This study shows that biomechanical pelvic blocking may not be effective immediately however it can be useful information to chiropractors when considering alternative treatment methods. Chiropractors should work together with podiatrist and biokineticists to help restore gait to its normal pattern through various treatment approaches.

6.2 Recommendations

The recommendations below may help in the improvement in future research studies:

- The study can be conducted over a longer period i.e. 3 weeks or 3 months to determine whether blocking has a long-term effect on gait.
- Treatment time can be increased to allow for better results as a longer treatment time could improve the effects of biomechanical pelvic blocking on the sacroiliac joint.
- Compare supine and prone blocking techniques - blocking in the supine position provides stability whilst blocking in the prone position provides mobility in the sacroiliac joint.
- A comparison between male and female groups due to difference in pelvic shape.
- Biomechanical pelvic blocking versus chiropractic manipulation and the combination thereof and it's immediate effect on gait.
- Chiropractic manipulation of the lower limbs in combination with pelvic blocking and its effects on gait.
- Biomechanical pelvic blocking and its effect on leg length inequality and gait parameters.
- The effects of pelvic blocking and its effects on foot pressure and centre of gravity in conjunction with gait parameters.

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APPENDICES

Appendix A – Advertisement

NEW CHIROPRACTIC RESEARCH

Are you between the ages of 18-30 years old?

Do you practise good spine care?

You may qualify to partake in the research study "Biomechanical Pelvic Blocking on Sacroiliac Dysfunction and its Immediate Effects on Gait" taking place at the University of Johannesburg Chiropractic Clinic.

Only one visit is required!

Please call **Sharné Pillay** on **083 785 1643**

OR

The **UJ Chiropractic Clinic** on **011 559 6493**

To make an appointment

University of Johannesburg ethics clearance number: REC-241112-035

UNIVERSITY OF JOHANNESBURG

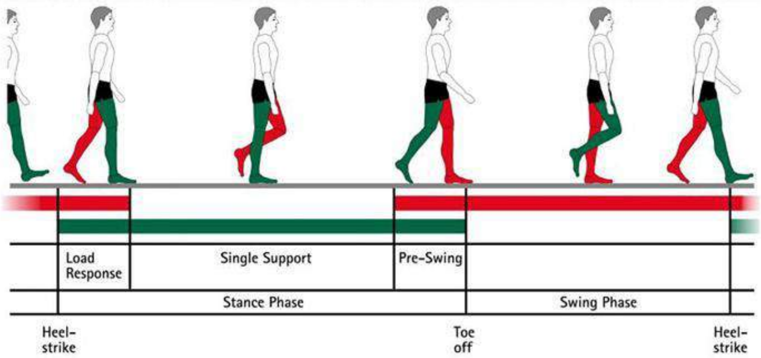
Appendix B – Zebris FDM Report

Project: Demo
Patient: Subject, Sample
Record: with Video

Zebris Gait Report

zebris

Date of meas.: 13.09.2007 15:04



Parameters

Parameter	Side	Value	Scale
Foot rotation, deg	Left	5.1±0.7	-40 / 60
	Right	6.3±1.2	-40 / 60
Step width, cm		6±1	100
Step length, cm	Left	54±1	130
	Right	52±1	130
Step time, sec	Left	0.73±0.00	3
	Right	0.66±0.01	3
Stance phase, %	Left	65.6±0.1	100
	Right	67.5±0.8	100
Load response, %	Left	15.0±1.4	100
	Right	18.3±0.2	100
Single support, %	Left	32.3±0.8	100
	Right	34.4±0.4	100
Pre-swing, %	Left	18.3±0.4	100
	Right	15.0±1.1	100
Swing phase, %	Left	34.4±0.1	100
	Right	32.5±0.8	100
Total Double support, %		33.0±0.9	100
Stride length, cm		104±2	200
Stride time, sec		1.40±0.01	3
Cadence, strides/min		43±0	100

Normative data: 2-5 km/h

Patient Comments

Record Comments

Page 2

Appendix C – Information Form

DEPARTMENT OF CHIROPRACTIC

RESEARCH STUDY INFORMATION LETTER

30/04/2018

Good day,

My name is Sharné Pillay I **WOULD LIKE TO INVITE YOU TO PARTICIPATE** in a research study on “Biomechanical Pelvic Blocking on Sacroiliac Dysfunction and its Immediate Effect on Gait”.

Before you decide on whether to participate, I would like to explain to you why the research is being done and what it will involve for you. **I will go through the information letter with you and answer any questions you have.** This should take about 10 to 20 minutes. This study is a research project being completed as a requirement for a Master’s Degree in Chiropractic through the University of Johannesburg.

THE PURPOSE OF THIS STUDY is to determine if the use of biomechanical pelvic blocks on sacroiliac dysfunction has an immediate effect on gait.

Below, I have compiled a set of questions and answers that I believe will assist you in understanding the relevant details of participation in this research study. Please read through this information. If you have any further questions, I will be happy to answer them for you.

DO I HAVE TO TAKE PART? No, you don’t have to. It is up to you to decide whether you would like to participate in this research study. I will describe the study and go through the information sheet. If you agree to take part, I will then ask you to sign a consent form.

WHAT EXACTLY WILL I BE EXPECTED TO DO IF I AGREE TO PARTICIPATE? There will be one hundred participants in this study including males and females. The participants must be between the ages of 18-30 years old. The inclusion criteria must be met to partake in the study and you should not have any diseases or pathology in your lower back, hips, knees and feet. Participants will initially be analysed on the Zebris FDM gait analysis system prior to physical assessment. A case history, physical examination and regional examination of your lower back will be done. A series of tests will also be completed to gather data. Thereafter, you will be randomly allocated into one of the two groups. If you are allocated to Group A, you will receive treatment for your sacro-iliac restriction with biomechanical pelvic blocks. If you are placed in Group B, you will not receive treatment as this is a control group. This treatment will be single session and will not require any follow-up appointments. The use of biomechanical pelvic blocks is a method of treatment that is non-invasive as it involves wedges placed under the pelvis and the force of gravity to restore the normal joint motion and position. Abnormal movement in the sacro-iliac joint will be detected by physical examination and motion palpation. This treatment is specifically advantageous for fragile patients or patients who are contra-indicated for chiropractic manipulation. Participation in this research will aid in improving treatment protocols for patients and provide more information about the effects of biomechanical pelvic blocking in the Chiropractic profession.

WHAT WILL HAPPEN IF I WANT TO WITHDRAW FROM THE STUDY? If you decide to participate, you are free to withdraw your consent at any time without giving a reason and without consequences. If you wish to withdraw your consent, you must inform me as soon as possible.

IF I CHOOSE TO PARTICIPATE, WILL THERE BE ANY EXPENSES FOR ME; OR PAYMENT DUE TO ME? You will not be paid to participate in this study nor will you bear any cost.

RISKS INVOLVED IN PARTICIPATION: The possible risks include post treatment stiffness; however, this is a normal response.

BENEFITS INVOLVED IN PARTICIPATION: The benefit of the study is the restoration of the sacro-iliac joint motion, which could improve the way you walk.

WILL MY PARTICIPATION IN THIS STUDY BE KEPT CONFIDENTIAL? Yes, Names on the data sheets will be removed once the analysis process starts. All data and back-ups thereof will be kept in password protected folders and/or locked away as applicable. Only I or my research supervisor will be authorised to use and/or disclose your anonymous information in connection with this research study. Any other person wishing to work with your anonymous information, as part of the research process (e.g. an independent data coder) will be required to sign confidentiality agreement before being allowed to do so.

WHAT WILL HAPPEN TO THE RESULTS OF THE RESEARCH STUDY? The results will be written into a research report that will be assessed. In some cases, results may also be published in a scientific journal. In either case, you will not be identifiable in any documents, reports or publications. You will be given access to the study results if you would like to see them, by contacting me.

WHO IS ORGANISING AND FUNDING THE STUDY? The study is being organised by me, under the guidance of my research supervisor at the Department of Chiropractic in the University of Johannesburg. All funding for the study will be provided by the supervisor linked bursary.

WHO HAS REVIEWED AND APPROVED THIS STUDY? Before this study could commence, it was reviewed to protect your interests. This review was done first by the Department of Chiropractic, and then secondly by the Faculty of Health Science Research Ethics Committee at the University of Johannesburg. In both cases, the study was approved.

WHAT IF THERE IS A PROBLEM? If you have any concerns about this research study, its procedures or risks and benefits, you should ask me. You should contact me at any time if you feel you have any concerns about being part of this study. My contact details are:

Sharné Pillay

Cell number: 0837851643

Email: sharne.pillay15@gmail.com

You may also contact my research supervisor:

Dr. Malany Moodley

Email: mmoodley@uj.ac.za

If you feel that any questions or complaints regarding your participation in this study have not been dealt with adequately, you may contact the Chairperson of the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg:

Prof. Christopher Stein

Tel: 011 559-6564

Email: cstein@uj.ac.za

FURTHER INFORMATION AND CONTACT DETAILS: Should you wish to have more specific information about this research project information, have any questions, concerns or complaints about this research study, its procedures, risks and benefits, you should communicate with me using any of the contact details given above.

Researcher:

Sharné Pillay

Ethics clearance number: REC-241112-035

Appendix D – Consent Form

UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF CHIROPRACTIC

RESEARCH CONSENT FORM

Biomechanical Pelvic Blocking on Sacroiliac Joint Dysfunction and its Immediate Effects on Gait

Please initial each box below:

☐ I confirm that I have read and understand the information dated 30/04/2018 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐ I understand that my participation is voluntarily and that I am free to withdraw from this study at any time without giving any reason and without any consequences to me.

☐ I agree to take part in the above study.

________________	____________________	________________
Name of Participant	Signature of Participant	Date
________________	____________________	________________
Name of Researcher	Signature of Researcher	Date

Appendix E – Case History Form

Research Copy

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

CASE HISTORY

Date: ______________________________

Patient: ______________________________ **File No:** ______________________________

Occupation: ______________________________ **Age**: __________ **Sex**: ________

Student: ______________________________ **Signature:** ______________________________

FOR CLINICIAN USE ONLY:

Initial visit clinician: ______________________________ **Signature:** ______________________________:

Case History: ____

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Examination:				
	Previous:	UJ Other	Current:	UJ Other
X-ray Studies:				
	Previous:	UJ Other	Current:	UJ Other
Clinical Path. Lab:				
	Previous:	UJ Other	Current:	UJ Other

Case status:

PTT: Conditional: Signed off: Final sign out:

Recommendations:

1

Students case history:

1. **Source of History:** ____

2. **Chief Complaint in patients own words:**

____

____

____

____

____

3. PRESENT ILLNESS/PRIMARY COMPLAINT

Location	
Onset	
Duration	
Frequency	
Pain Character	
Progression	
Aggravating Factors	
Relieving Factors	
Ass Signs & Symptoms	
Previous Occurrence	
Past Tx and Outcomes	

4. PAST HISTORY

General Health Status	
Childhood Illnesses	
Adult Illnesses	
Psychiatric Illnesses	
Accidents	
Traumatic Injuries	
Surgeries	
Hospitalizations	

5. **ANY OTHER COMPLAINTS**

____

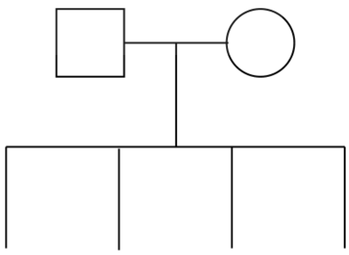
____

6. CURRENT HEALTH STATUS & LIFESTYLE

Allergies	
Immunizations	
Screening Tests	
Environmental Hazards	
Safety Measures	
Progression	
Exercise and Leisure	
Sleep Patterns	
Diet	
Current Mediation	
Tobacco	
Alcohol	
Social Drugs	
Other	

7. FAMILY HISTORY

Diabetes Mellitus	
Heart Disease	
TB	
HBP	
Stroke	
Kidney Disease	
Cancer	
Arthritis	
Anaemia	
Headaches	
Thyroid Diseases	
Epilepsy	
Mental Illness	
Alcoholism	
Drug Addiction	
Other	



8. PSYCHOSOCIAL HISTORY

Home Situation	
Daily Life	
Important Experiences	
Religious Beliefs	
Other	

9. REVIEW OF SYSTEMS

General	
Skin	
Head	
Eyes	
Ears	
Noses / Sinuses	
Mouth / Throat	
Neck	
Breasts	
Respiratory	
Cardiac	
Gastrointestinal	
Urinary	
Genital/Sexual Function	
Vascular	
Musculoskeletal	
Neurological	
Hematological	
Endocrine	
Psychiatric	
Other	

Appendix F – Physical Examination Form

Research Copy

UNIVERSITY OF JOHANNESBURG

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

PHYSICAL EXAMINATION

Underline abnormal findings in **RED**

Date: ______________________________

Patient: ______________________________

File No: ______________________________

Clinician : ______________________________

Signature: ______________________________

Student: ______________________________

Signature: ______________________________

VITAL SIGNS

Height	
Weight	
Temperature	
Heart Rate	
Pulse	
Respiratory Rate	

BLOOD PRESSURE

	Left	Right
Arms		
Legs		

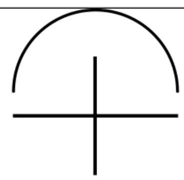
General Appearance

____

____

____

STANDING EXAMINATION

Minor's Sign	
Skin Changes	
Posture • Erect • Adams	
Romberg's Sign	
Pronator Drift	
Trendelenburg Sign	
Gait • Rhythm • Balance • Pendulousness • On toes • On heels • Tandem	
Half Squat	
Scapular Winging	
Muscle Tone	
Spasticity / Rigidity	
Chest measurement • Inspiration • Expiration	 __________ **cm** __________ **cm**
Visual Acuity	
Lumbar Spine ROM • Flexion (90º) • Extension (50º) • Lat. Flexion (30º) • Rotation (35º)	

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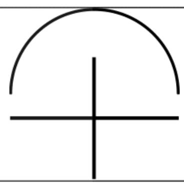
SEATED EXAMINATION

Spinal Posture	
Head • Hair & Skin • Scalp • Skull • Face	
Eyes • Observation - Conjunctiva - Sclera - Eyebrows & Lids - Lacrimal Glands - Nasolacrimal Duct - Position - Alignment - Cornea / Lens • Corneal Reflex • Ocular Movements • Visual Fields • Accommodation • Ophthalmoscopy - Iris - Pupils - Red Reflex - Optic Disc - Macula - Vitreous - Lens	
Ears • Inspection - Auricle - Ear Canal - Drum • Auditory Acuity • Weber Test • Rinne Test	
Nose • External Inspection • Internal Inspection - Septum - Turbinate - Olfaction	
Sinuses • Tenderness • Transillumination	

SEATED EXAMINATION Cont.

Mouth & Pharynx • Lips • Buccal Mucosa • Gums & Teeth • Roof • Tongue - Inspection - Movements - Taste - Palpation • Pharynx – CN X	
TMJ • Inspection - ROM - Deviation • Palpation - Crepitus - Tenderness	
Neck • Posture • Size / Swellings • Scars • Discolorations • Hairline • Lymph Nodes • Tracheal Alignment • Thyroid & Carotids	
Cervical Spine ROM • Flexion (45º) • Extension (55º) • Lat. Flexion (40º) • Rotation (70º)	
Peripheral Vascular • Inspection - Pigmentation, Skin, Nailbeds, Hair loss • Palpation - Pulses, Lymph nodes, Skin Temp • Manual Compression • Retrograde Filling • Arterial Insufficiency • Allan's Test	

BREAST

Inspection • Skin • Size • Contour • Nipples • Arms Overhead • Hands Against Hips • Leaning Forward	
Palpation • Axillary Lymph Nodes • Breast • Breast tail	

THORAX – HEART AND LUNGS

Inspection • Skin • Shape • Respiratory Distress • Rhythm • Depth • Effort • Intercostal Retraction	
Palpation • Tenderness • Masses • Respiratory Expansion • Tactile Fremitus • JVP • PMI	
Percussion • Lungs (posterior) • Diaphgragmatic excursion • Kidney Punch	
Auscultation • Breath Sounds • Adventitious Sounds • Voice Sounds • Heart Auscultation • Heart Murmurs	

ABDOMINAL

Inspection • Skin • Umbilicus • Contour • Peristalsis • Pulsations • Hernias	
Auscultation • Bowel Sounds • Bruits	
Percussion • General • Liver • Spleen	
Palpation • Superficial Reflex • Cough • Light • Rebound Tenderness • Deep • Liver • Spleen • Kidneys • Aorta • Abdominal Masses • Shifting Dullness • Fluid Wave	
Acute Abdomen • Where pain began? • Moved to where? • Cough • Tenderness • Guarding / Rigidity • Rebound Tenderness	
Special Tests • Rovsing's Sign • Psoas Sign • Obturator Sign • Cutaneous Hyperaesthesia • Murphy's Sign • Rectal Examination	

MUSCULOSKELETAL

Shoulder • Observation - Skin - Symmetry • ROM - Glenohumeral - Scapulo-thoracic - Acromioclavicular - Elbow - Wrist		
Hip	Left	Right
• Flexion (90° / 120°)		
• Extension (15°)		
• Abduction (45°)		
• Adduction (30°)		
• Internal Rotation (40°)		
• External Rotation (45°)		
Knee	Left	Right
• Flexion (30°)		
• Extension (0° / 15°)		
Ankle	Left	Right
• Plantar Flexion (45°)		
• Dorsi Flexion (20°)		
• Inversion (30°)		
• Eversion (20°)		
Leg Length	Left	Right
• Apparent		
• Actual		

CO-ORDINATION AND CEREBELLAR TESTING

Vertigo	
Ataxic Gait	
Nystagmus	
Intention Tremor	
Slurring/ Staccato Speech	
Hypotension	
Dysmetria (Point to point)	
Dysdiachokinesia	
Titubation	

MENTAL STATUS

Appearance & Behavior • LOC • Posture • Motor Behavior • Dress, Grooming • Facial Expression • Affect	
Speed & Language • Quantity • Rate • Volume • Fluency • Aphasia (pm)	
Mood	
Memory • Orientation • Remote Memory • Recent Memory • New Learning Ability	
Higher Cognitive Function • Information • Vocabulary • Abstract Thinking	

CRANIAL NERVES

	Left	Right
CN I – Olfactory		
CN II – Optic		
CN III – Oculomotor		
CN IV - Trochlear		
CN V – Trigeminal • Motor • Sensory		
CN VI – Abducens		
CN VII – Facial • Motor • Sensory		
CN VIII - Vestibulocochlear		
CN IX – Glossopharyngeal		
CN X – Vagus		
CN XI – Spinal Accessory		
CN XII - Hypoglossal		

NEUROLOGICAL ASSESSMENT

DERMATOMES

	Left	Right
Cervical		
C2		
C3		
C4		
C5		
C6		
C7		
C8		
T1		
T2		
Lumbar		
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		

REFLEXES

	Level	Left	Right
Cervical			
Biceps	C5		
Brachioradialis	C6		
Triceps	C7		
Lumbar			
Patella	L3 / L4		
Medial Hamstring	L5		
Lateral Hamstring	S1		
Tibialis Posterior	L4 / L5		
Achilles	S1 / S2		
Plantar Reflex			

NEUROLOGICAL ASSESSMENT

MYOTOMES

	Level	Left	Right
Cervical			
Neck Forward Flexion	C1 / C2		
Neck Lateral Flexion	C3		
Shoulder Elevation	C4		
Shoulder Abduction	C5		
Elbow Flexion	C5		
Elbow Extension	C7		
Elbow Flexion	C6		
Forearm Pronation	C6		
Forearm Supination	C6		
Wrist Extension	C6		
Wrist Flexion	C7		
Finger Flexion	C8		
Finger Abduction	T1		
Finger Adduction	T1		
Lumbar			
Hip Flexion	L1 / L2		
Knee Extension	L2 / L3 / L4		
Knee Flexion	L5 / S1		
Hip Internal Rotation	L4 / L5		
Hip External Rotation	L5 / S1		
Hip Adduction	L2 / L3 / L4		
Hip Abduction	L4 / L5		
Ankle Dorsiflexion	L4 / L5		
Ankle Plantar Flexion	S1 / S2		
Hallux Extension	L5		
Eversion	S1		
Inversion	L4		
Hip Extension	L5 / S1		

Appendix G – Lumbar Spine and Pelvis Examination

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC

REGIONAL EXAMINATION
LUMBAR SPINE

Date: ____________________

Patient: ____________________ **File No:** ____________________

Clinician: ____________________ **Signature:** ____________________

Student: ____________________ **Signature:** ____________________

OBSERVATION

Body Type	
Posture	
Muscle Tone	
Bony Contours	
Soft Tissue Contours	
Skin	
Fasciculations	
Scars	
Discolourations	
Step Deformities	
Plumb lines • Frontal plane • Sagittal Plane	

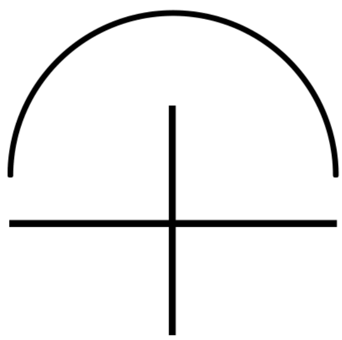
MYOFASCIAL – ACTIVE TRIGGER POINTS

	Left	Right
Quadratus Lumborum		
Erector Spinae		
Gluteus Maximus		
Gluteus Medius		
Gluteus Minimus		
TFL		
Piriformis		
Hamstrings		
Iliopsoas		

PALPATION

Iliac Crest	
Lumbar Spinous Process	
Muscle Bulk	
Sacro-iliac Joints	
Sacrum	

RANGE OF MOTION



GAIT

Rhythm, Pendulousness	
On Toes (S1)	
On Heels (L4 / L5)	
Half Squat on One Leg	
Tandem Walking	

NEUROLOGICAL ASSESSMENT

DERMATOMES

	Left	Right
T12		
L1		
L2		
L3		
L4		
L5		
S1		
S2		
S3		

NEUROLOGICAL ASSESSMENT

REFLEXES

	Level	Left	Right
Patella	L3 / L4		
Medial Hamstring	L5		
Lateral Hamstring	S1		
Tibialis Posterior	L4 / L5		
Achilles	S1 / S2		
Plantar Reflex			

REFLEX GRADING

- 4+ Very brisk, hyperactive. Perform ankle clonus.
- 2+ Average; normal
- 1+ Somewhat diminished; low normal.
- 0 No response

MUSCLE CIRCUMFERENCE

	Left	Right
Thigh	Cm	Cm
Calf	Cm	Cm

LEG LENGTH

	Left	Right
Actual	Cm	Cm
Apparent	Cm	Cm

NEUROLOGICAL ASSESSMENT

MYOTOMES

Hip Flexion	L1 / L2	Left	Right
Knee Extension	L2 / L3 / L4		
Knee Flexion	L5 / S1		
Hip Internal Rotation	L4 / L5		
Hip External Rotation	L5 / S1		
Hip Adduction	L2 / L3 / L4		
Hip Abduction	L4 / L5		
Ankle Dorsiflexion	L4 / L5		
Ankle Plantar Flexion	S1 / S2		
Hallux Extension	L5		
Eversion	S1		
Inversion	L4		
Hip Extension	L5 / S1		

MUSCLE GRADING

- 0 - No contraction detected
- 1 - Barely detectable flicker or trace of contraction
- 2 - Active movement with gravity eliminated
- 3 - Active movement against gravity
- 4 - Active movement against gravity and some resistance.

ABDOMINAL EXAMINATION

Observation	
Abdominal Reflexes	
Auscultation of Abdomen	
Auscultation of Groin	
Palpation of Abdomen	
Palpation of Groin	
Palpation of Abdominal Aorta	

PULSES

Femoral	
Popliteal	
Dorsalis Pedis	
Posterior Tibial	

ORTHOPAEDIC TESTS

	Left	Right
Standing		
Schober's Test		
Spinous Percussion		
Treadmill		
Minor's Sign		
Quick Test		
Trendelenburg's Test		
Seated		
Tripod Test		
Kemp's Test		
Valsalva Manoeuvre		
Supine		
SLR		
WLR		
Braggard's		
Bowstring's		
Sciatic Notch Pressure		
Sign of The Buttock		
Bilateral SLR		
Patrick Fabere's		
Gaenslen's Test		
"Squish" Test		
"Gapping" Test		
Gluteus Medius Stretch		
Thomas' Test		
Rectus Fem Contracture		
Hip Medial Rotation		
Psoas Test		
Lateral Recumbent		
Sacro-iliac Compression		
Ober's Test		
Femoral Nerve Stretch		
Prone		
Facet Joint Challenge		
Skin Rolling		
Erichsen's Test		
Sacro-Iliac Tenderness		
Pheasant's Test		
Gluteal Skyline		

NON-ORGANIC TESTS

	Left	Right
Pin-Point pain		
Axial Compression		
Trunk Rotation		
Burn's Bench Test		
Flip Test		
Hoover's Test		
Ankle Dorsiflexion Test		
Pin-Point Pain		

MOTION PALPATION

	Left	Right
T7 / T8		
T8 / T9		
T9 / T10		
T10 / T11		
T11 / T12		
T12 / L1		
L1 / L2		
L2 / L3		
L3 / L4		
L4 / L5		
L5 / S1		
Sacro-iliac Joint		

GENERAL COMMENTS:

Appendix H – SOAP Note

UNIVERSITY OF JOHANNESBURG
CHIROPRACTIC DAY CLINIC
SOAP NOTE

Research Copy

Patient:	Visit Number:
File Number:	Student:
Date:	Clinician:
S:	O:
A: Differential Diagnosis / ICD-10 Code	P: Procedure Codes
Home Advice:	Comments:

Patient:	Visit Number:
File Number:	Student:
Date:	Clinician:
S:	O:
A: Differential Diagnosis / ICD-10 Code	P: Procedure Codes
Home Advice:	Comments:

Appendix I – Research Ethics Committee Clearance Number

FACULTY OF HEALTH SCIENCES

RESEARCH ETHICS COMMITTEE

NHREC Registration no: REC-241112-035

REC-01-20- 2018

26 April 2018

TO WHOM IT MAY CONCERN:

STUDENT:	PILLAY, S
STUDENT NUMBER:	201304117
TITLE OF RESEARCH PROJECT:	Biomedical Pelvic Blocking on Sacroiliac Joint Dysfunction and its Immediate Effect on Gait
DEPARTMENT OR PROGRAMME:	CHIROPRACTIC
SUPERVISOR: Dr M Moodley	**CO-SUPERVISOR:** -

The Faculty Research Ethics Committee has scrutinised your research proposal and confirm that it complies with the approved ethical standards of the Faculty of Health Sciences; University of Johannesburg.

The REC would like to extend their best wishes to you with your postgraduate studies.

Yours sincerely,

Prof C Stein
Chair : Faculty of Health Sciences REC
Tel: 011 559 6564
Email: cstein@uj.ac.za

Appendix J – Letter from the Higher Degrees Committee

FACULTY OF HEALTH SCIENCES
HIGHER DEGREES COMMITTEE

23 March 2018

TO WHOM IT MAY CONCERN:

Student:	PILLAY, S
Student Number:	201304117

TITLE OF RESEARCH PROPOSAL:	Biomedical Pelvic Blocking on Sacroiliac Joint Dysfunction and its Immediate Effect on Gait
DEPARTMENT OR PROGRAMME:	CHIROPRACTIC

SUPERVISOR: Dr M Moodley **CO-SUPERVISOR:** -

The Faculty Higher Degrees Committee has scrutinised your research proposal and confirms that it complies with the approved research standards of the Faculty of Health Sciences; University of Johannesburg.

The proposal has been awarded a Code 2A – Approved with suggestions, without re-submission. Attached recommendations were made by the Committee which will add value to your proposal.

Please make these amendments to the satisfaction of your supervisor/s and submit a corrected copy of the proposal to the Faculty Research Administrator after which your clearance number will be issued.

The HDC would like to extend their best wishes to you with your postgraduate studies.

Yours sincerely

Prof BS Shaw
Chair: Faculty of Health Sciences HDC
Tel: 011 559 6891
Email: brandons@uj.ac.za

Appendix K – Turnitin Report

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

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Assignment title:	Submit proposals, theses, disserta...
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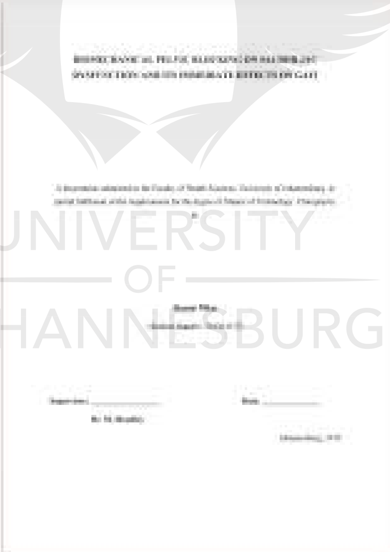
File size:	4M
Page count:	89
Word count:	19,616
Character count:	100,043
Submission date:	03-May-2019 01:02PM (UTC+0200)
Submission ID:	1076264356

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S PILLAY
BIOMECHANICAL PELVIC BLOCKING AND ITS IMMEDIATE EFFECT ON GAIT
BIOMECHANICAL PELVIC BLOCKING ON SACROILIAC DYSFUNCTION AND ITS IMMEDIATE EFFECTS ON GAIT
A dissertation submitted to the Faculty of Health Sciences, University of Johannesburg, in partial fulfilment of the requirements for the degree of Master of Technology: Chiropractic
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